The American

GAS LIGHT JOURNAL.

(ILLUSTRATED.)

DEVOTED TO THE INTERESTS OF

ILLUMINATION, HEATING, MECHANICAL, CHEMICAL

—AND—

GENERAL SCIENCE.

VOLUME LXVI.

(THIRTY-NINTH YEAR.)

FROM JANUARY 1 TO JUNE 30, 1897.

A. M. CALLENDER & CO., Publishers.

OFFICE OF PUBLICATION, NO. 32 PINE STREET, NEW YORK CITY.

A. G. L. Co.

THE AMERICAN GAS LIGHT JOURNAL

REDMAN & KENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXVI.—No. 1. Whole No. 1,126. | NEW YORK, MONDAY, JANUARY 4, 1897 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, New York.

Collections are invariably made directly from this office for subscriptions, advertisements, etc. We have agents to solicit the same, but they are not authorized to receipt for money.

Terms of Subscription, Including Postage.—For the United States and Canada, $3 per annum. European countries, $4.50 (19 shillings—22½ francs). All payments to be made in advance. Single copies, 10 cents.

The American News Company, Nos. 39 and 41 Chambers street, New York, are agents for this JOURNAL. Newsdealers will send orders to them.

Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

Remittances should be made either by post office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

OFFICIAL NOTICES—
- January Meeting, Society of Gas Lighting 1
- January Meeting, Guild of Gas Managers 1
- Proprietor's Announcement—The Editorial Direction of the JOURNAL 1

EDITORIALS—
- Briefly Told 1
  - Put Coal Tar on the Dutiable List—A Loss, Not a Profit, in Operating the Philadelphia Municipal Gas Works—Notes.
- Domestic Illumination by Means of Gas, by Vivian B. Lewes, F.I.C., F.C.S.—Third (and last) Cantor Lecture 2
- *On some New Forms of Gas Generators for Laboratories, by Mr. Thomas H. Norton 7
- *Hand Feed Electric Lamp for Lanterns 8
- Aluminum Bronze Seamless Tubing 8
- Natural Waters and their Effects in Steam Boilers, by Mr. George W. Lord 9
- *The Piftin Rotary Pump 10
- On the Behavior of Coal Tar Colors toward the Process of Digestion 10
- Coal in Montana 11

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 12
- Cheaper Gas for Newport, R. I.—Mr. Rogers Named to the Vice-Presidency of the Brookline Company—Fuel Gas Franchise for Norwalk, O.—Contract for the Berlin Company—Changes at Hackensack, N.J.—Pintsch Gas Plant for Pittsburgh, Pa.—Cheaper Gas for Rome, N. Y.—Medford, Mass., and Municipal Lighting—Explosion in the Elyria (O.) Works—Annual Meeting, Ilion, N.Y.—First Meeting of the New York Aldermanic Committee to Examine into the Gas Supply Conditions—Mr. Dunning Makes a Proposal—A Hint from Philadelphia—The Bristol Company's New Catalogue—A Specimen of Welsbach Lighting, Columbus, O.—A Correction—Something from Little Rock, Ark.—An Explosion of Acetylene Gas, Berlin, Germany—Proposals for Public Lighting, New York City—And Other Items.

- The Roentgen Rays in Pharmacy 13
- The Market for Gas Securities 14

[OFFICIAL NOTICE.]

January Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, Dec. 26, 1896.

The January meeting of the Society of Gas Lighting will be held in the works of the New York Mutual Gas Light Company, Eleventh street and Avenue D, New York, at 3 P.M., of the 14th inst.

FRED. S. BENSON, Secretary.

[OFFICIAL NOTICE.]

January Meeting, Guild of Gas Managers.

OFFICE OF THE SECRETARY, Dec. 24, 1896.

The January meeting of the Guild of Gas Managers will be held in Young's Hotel, Boston, Mass., at noon of Saturday, the 9th inst.

A. K. QUINN, Secretary.

THE EDITORIAL DIRECTION OF THE JOURNAL.

The staff vacancy caused by the death of Mr. Joseph R. Thomas, who since 1883, had editorial control of the JOURNAL, has been filled by the appointment of Mr. Thomas J. Cunningham and Mr. Elbert P. Callender to the editorial direction, both of whom are in complete accord with the fixed policy and practice that have long prevailed in the JOURNAL's management. The aim and purpose of the JOURNAL, in the future as in the past, will be to advance the best interests of the profession and industry with which our welfare and advancement are indissolubly bound.

A. M. CALLENDER & CO.

BRIEFLY TOLD.

PUT COAL TAR ON THE DUTIABLE LIST.—It is fairly certain that under the new administration material changes will be brought about in the tariff schedules, and in that understanding, and without any reference whatever as to whether the principles underlying protection or free trade are those that should obtain in the practice of the government towards manufacturing and other interests, it would seem only in line with the veriest commonsense that the gas makers should see to it that in the new schedules a fair import duty is placed on tar and tar products. Some years ago such products were on the dutiable list, but when the tar combination in this country had reached a point in organization where it virtually controlled the home markets as to the price which it would pay for the crude tar offered for sale, it further strengthened its grip by successfully appealing to Congress to remit the duty on the foreign article. That this appeal was so successfully made reflects no particular credit on the watchfulness of the gas makers of this country, even if it did prove that the tar buyers were quite up to performing their freeing act without an undue heralding of their intentions. Having enjoyed the blessings of free tar for some years, it might be in order, that all should share the profit that comes from legislative intervention, that the tar buyers and distillers should offer no strenuous

opposition to a proposition to restore the material under consideration to the dutiable list; but we fear the tar trust gentlemen are not of that temper. Aside from such a speculation, however, the fact remains that the gas makers should without delay take sensible steps towards ridding themselves from the incubus of competing with the "pauper tar" of Europe—a competition from which they have suffered too long, and with too great an exhibition of docility. If newspaper report is to be credited, the tar people have already made their appearance before the Congress Committee that is considering the Dingley bill, with a request that tar be continued on the free list, wherefore the tar makers should be up and doing. Perhaps the American Gas Light Association, through its Council, should be the body to take the initiative in this most important matter; but we do not desire to figure as declaring whose particular duty it should be. Our object is merely to call attention to the fact that speedy action must be taken, for the Committees of the Congress having the schedules in charge will, as we understand it, reach the matter of "coal" on the 11th inst., on which same day the related subject of coal tar would be considered.

A Loss, not a Profit, in Operating the Philadelphia Municipal Gas Works.—Whenever and wherever we have reports of what goes on in assemblages called together for the purpose of advocating the municipal control of lighting plants, the story of what has been accomplished by the municipality of Philadelphia, in owning and controlling its gas works and gas supply, is sure to be cited as evidence that the communities in which the particular set of agitators live should "do likewise." Philadelphia for some time has been selling gas at $1 per 1,000 cubic feet, and the experiment has been carried on for a period sufficiently long to enable unprejudiced observers to come to a fair conclusion over it. The consensus of opinion amongst such observers, who are well qualified to reach a conclusion that will hold, since they themselves are engaged in the business of gas manufacture and distribution, is that Philadelphia has been losing a round percentage on every 1,000 feet sold at the $1 rate. That fact was brought out in all its bareness about a fortnight ago, during the investigation of the branches of the Philadelphia municipal government by a special committee of the State Senate. When the Gas Bureau was gotten to for probing, some important developments came to light. Several expert witnesses were summoned, amongst whom were Mr. Eugene Vanderpool, whose great ability as a gas engineer cannot be denied, and whose standing as a man whose opinions are his own, absolutely and unpurchasable, may not be controverted. In his testimony Mr. Vanderpool declared that, taking due account of *all* proper factors that should be considered in connection with the existing conditions of gas manufacture and distribution in Philadelphia, the cost per 1,000 cubic feet would be $1.36, thus showing a loss of 36 cents per 1,000 of gas distributed. Under the peculiar bookkeeping methods of the Bureau, however, a difference of $200,000 in its favor as the result of the operations for the last year is shown. Of course, Mr. Vanderpool, in his testimony, allowed for all classes of losses, such as leakage (which there amounts to over 20 per cent.), non-payment of taxes, failure to charge anything for plant depreciation, antiquated manufacturing and distributing plant and systems, etc. Another witness (Prof. Edward W. Bemis, of Chicago, whose ideas over the plan of municipal control of lighting enterprises are quite in favor of that practice), admitted that the Philadelphia plant was in no sense a modern one, nor anything like in value that put upon it by the city. In fine, the testimony before the Senate Committee all went to show that the Philadelphia gas works may be confidently pointed to as a positive example why such enterprises should be under private direction rather than in public control.

Notes.—The Western Gas Fixture Company has been incorporated in Toledo, O., with a capital of $20,000.——The Springfield (Mo.) Lighting Company has filed a certificate, decreasing its capital stock from $160,000 to $125,000.——The proposition to establish the office of gas inspector in Kansas City, Mo., has been amended to death by Councils.——The item in the budget of Washington, D. C., for the public lighting of that city for the ensuing year, provides for the disbursing of $203,793.64 for gas and gasoline lamps, and $96,943.50 for electric lights. The understanding further is that not more than $20 shall be paid per annum for each gas lamp, and that the lamps shall burn every night, on the average, from 45 minutes after sunset until 45 minutes before sunrise. The electric specifications name 30 cents as the maximum price to be paid per night for each arc light (of 1,000 *actual* candle power), the hours of lighting to be identical with those named on gas account. It is also declared that the "electric supply shall be operated wholly by means of underground wires."

Domestic Illumination by Means of Gas.

[The Third (and last) of a Series of Three Cantor Lectures, delivered by Mr. Vivian B. Lewes, F.I.C., F.C.S., before the Society of Arts, London, England.]

Though coal gas is by far the best illuminant that can be employed, there are many villages and small towns still existing where the limited consumption would render gas works commercially impossible, and where, therefore, the oil lamp and candle still reign as the chief methods of obtaining light. Under these circumstances, also in country houses and institutions, such as workhouses, hospitals, infirmaries, etc., gas made from substances other than coal is frequently employed.

The great class of bodies which we call hydrocarbons, and which include all the waxes, fats and oils, and many gaseous compounds, have been shown by experiment to be simplified in their composition by the action of heat. The more complex ones, in which many atoms are packed away in a molecule, have, as a rule, the solid form, such as a wax or fat. On heating, these complex bodies break up, and become simplified in form; and among the less complex the liquid hydrocarbons play an important part. These again become further simplified by the action of a higher temperature or more prolonged heating, until the simplest or gaseous hydrocarbons are obtained; while these latter can again be broken up into their constituents—carbon and hydrogen. It is therefore manifest that, given a solid or liquid compound of carbon and hydrogen, these may be converted into gaseous matter with much the same characteristics as are to be found in coal gas; and oil gas made by the breaking up of various grades of oil has been in use for as long a period as coal gas itself.

Many forms of apparatus have been devised for the production of this gas, but most of them only differ from each other in the general arrangement of the apparatus, and not in any specific principle. Of these oil gas processes, those which have received the most general support have been the Pintsch, Pope and Patterson, the chief differences between which are in the shape of the retort and the method of introducing the oil into it; and all such methods of decomposition give liquid and solid residuals as well as the oil gas.

The Patterson plant consists of a horizontal retort of cylindrical form built into a furnace, containing an oven or flue space in which the retort is placed. The oil to be converted into gas is led from the oil tank into the retort by two straight horizontal pipes extending from the front nearly to the back of the retort; the inner or back ends of these pipes being open. The supply of oil is partly converted into vapor while passing along these pipes, and on issuing from the ends it is further decomposed by the heat in its passage from the back to the front of the retort, where the outlet is situated. The main supply of oil is regulated by a stop-cock, while another tap on each retort pipe controls the supply to the retorts. The gas passes from the retorts into an atmospheric condenser, and then into the holder. The arrangements of the apparatus allow of the action being easily and satisfactorily regulated and controlled.

The manufacture of an oil gas in any such apparatus requires care in the selection of the material to be decomposed. The essential points which govern the selection are, first of all, the cost of the crude material, and secondly, the ease of working. A long series of experiments made by me to ascertain which is the best hydrocarbon to employ and the best temperature at which to work, gave 900° C. as that at which the best results are obtained, and that the oils most suitable for use are the Russian "Solar distillate," obtained by further distillation of the residue of Russian Baku oils after the lighter kerosenes have been driven off. Nearly as good are the blue and green shale oils. Working with these oils at a temperature of 900° C., the best results obtainable per gallon would be 98 cubic feet of 50-candle gas, which would be equal to 980 candles per gallon of oil. In each case there would be about 20 per cent. of the volume of the original oil condensed as residuals, these latter containing a certain amount of benzine as well as paraffines and olefines of low boiling points, but of very little use for re-cracking.

From time to time attempts have been made to manufacture an oil gas so that there shall be no liquid residues, and that the whole of the oil shall be converted into gas or left as a solid residue in the retorts. The first process of this kind was one introduced in 1846, by Hilary, who placed tube condensers above his oil retorts, so that all the liquid condensed ran back into the retorts and became further carbonized—his ultimate products being nothing but coke and gas. This idea has been further improved by Mr. W. Young, whose method of retorting oil in such a way as to yield nothing but coke and gas has achieved a

great success, and plays a very important part in the methods of enriching poor coal gas now largely adopted in the North of England and Scotland, in which oil gas takes the place of cannel in bringing up a 15-candle coal gas to the absurd standard which public opinion there seems to think necessary. Young's process from the manufacture of oil gas from the Scotch shale oils is entirely dependent upon the principle of washing the oil gas, retorted at a moderate temperature, by means of the oil which is afterwards to undergo decomposition—a process which frees it from all condensable vapors, and allows only permanent gases to escape to the purifiers. There is no doubt that, in doing this, very considerable quantities of the olefines and other fixed gases are also absorbed, but as these are driven out again by the action of the heat in retorting, no loss takes place. [The lecturer described the plant and process.]

The gas obtained by this process, when consumed *per se* in the burners most suited for its consumption, gives in the photometer an illuminating value of 50 to 60 candles; but the enriching value is said to be considerably above this. The reason for this phenomenon is that the duty obtainable from any burner is entirely dependent upon the regulation of the size of the flame so that the gases, as they burn, shall get a proper proportion of oxygen within a reasonable distance of the nozzle of the burner, and also upon the temperature of the flame itself. From this it will be seen that a gas of a certain illuminating power will give varying results according to the burners in which it is consumed; the burner suited for a poor coal gas being utterly unfitted for a rich gas—a point which is too often overlooked, not only in testing the illuminating value of gases, but also in their practical consumption. A 16-candle gas requires a very large burner in order that the best results may be obtained from it as a flat flame. But the size of the burner has to be rapidly decreased as the proportion of heavy hydrocarbons in the gas increases, as sufficient air must be supplied to the flame to enable it to burn without smoking. The smaller the flame the greater will be the cooling action of the nitrogen of the air, and also of the burner. The result is a burner has to be selected for each gas of such size that the gas will burn just without smoking.

If an oil gas, for instance, be taken, which is capable of emitting an illuminating value of 50 candles per 5 cubic feet, it will be found that a No. 2 Bray burner will give a heavy, smoky flame; and this would be worse as the size of the burner increases. But if a No. 0 Bray were employed, a smokeless flame would be the result; and this burner would give an illuminating value slightly under 50 candles per 5 cubic feet of gas consumed. If the size of the burner be now decreased, the illuminating power recorded will also decrease, until with a No. 000 Bray the gas would only have an illuminating power of 35 candles per 5 cubic feet, this falling off being entirely due to the cooling of the flame. Manifestly, therefore, with such a gas, the No. 0 burner would be the best to employ in order to get the highest results from it. With 60-candle gas it is impossible to get a burner which will develop the maximum illuminating power, as the cooling action destroys a large percentage of the value of the gas, the burner having to be so small in order to yield a flame which shall not smoke. For this reason it often happens that the enriching value of an oil gas is higher than would be expected from the results obtained when the gas is burnt by itself in the photometer.

The differences which exist in chemical composition between oil gas made by the various processes are, after all, but slight. The Young process, however, owing to the slightly lower temperature which is employed, gives a gas which is richer in unsaturated hydrocarbons—*i. e*, hydrocarbons which have the greatest power of illumination during combustion, and which consist chiefly of ethylene and butylene, the average of many analyses of gases being comprised in the follow- table:

	Young.	Patterson.	Pintsch.
Unsaturated hydrocarbons	43.83	33.16	35.65
Saturated hydrocarbons.....	36.30	45.15	45.37
Hydrogen	16.85	19.65	12.44
Carbon dioxide	0.63	0.50	0.74
Carbon monoxide.....	0.00	0.50	0.60
Oxygen.....	1.14	0.60	2.00
Nitrogen	1.25	0.44	3.20
	100.00	100.00	100.00

For domestic illumination oil gas has many drawbacks. In the first place, the apparatus which has to be employed for its manufacture is almost as bulky as a small coal gas installation, and necessitates scrubbers of much the same character; and keeping the furnace heats constant for raising the temperature of the retorts requires most careful attention, as otherwise stopped ascension pipes and burnt retorts constitute a very serious cause of delay and expense. In the consumption of the gas, moreover, the burners employed have to be so small as to seriously detract from the illuminating value of the gas; and its tendency to smoke when any considerable variation in its richness in hydrocarbons takes place, is anything but an endearing quality to the country householder.

At the present time the introduction of acetylene gas, made by the action of water upon calcic carbide, which is at once the most easily made and the most brilliant illuminant of all known gases, promises a complete revolution in domestic lighting where coal gas is not to be obtained. But much has yet to be done in educating the public as to the proper way in which to use it, and also in the character of the carbide from which it is produced, and in the forms of apparatus used to generate the gas. Acetylene (or, as it is sometimes scientifically called, ethine) is a gaseous compound of 24 parts by weight of carbon with 2 parts of hydrogen; and it was first discovered and isolated by Edmund Davy in 1836. It was not until 1859, however, that Berthelot's investigations gave the scientific world a clear conception of its interesting character and properties. Since that time it has frequently been prepared in small quantities by tedious and costly processes. It is only within the last few years that a cheap and simple method has been discovered, and has brought its use within the range of commercial possibility.

The fact that carbon and lime could be made to directly act upon each to form calcic carbide was discovered independently by Willson in America and in France by M. Moissan. But there exists abundant proof that Willson was making and experimenting with calcic carbide, and had sent specimens of it to various correspondents, some time before Moissan had made any announcement of his discovery; and, therefore, priority undoubtedly rests with the American discoverer. Calcic carbide is a dark grey substance, having a specific gravity of 2.262, and, when pure, 1 lb. of it will yield on decomposition 5.8 cubic feet of acetylene. Unless, however, it is quite fresh, or means have been taken to carefully protect it from air, the outer surface becomes slightly acted upon by atmospheric moisture, so that in practice the yield would not exceed 5 cubic feet. The density and hardness of the mass protect it to a great extent from atmospheric action; so that in lumps it does not deteriorate so fast as would be expected. In the powdered condition, however, it is quickly decomposed. On the addition of water to the calcic carbide, a double decomposition takes place—the oxygen of the water combining with the calcium, and once again forming lime, while the hydrogen unites with the carbon of the carbide to form acetylene.

At the present moment, the future of acetylene as an illuminant is largely dependent upon two factors—first, the commercial production of calcic carbide of a reasonable degree of purity; and, secondly, methods for safely making and burning the gas in such a way as to develop its full illuminating power while doing away with the risk of smoking. As I first drew attention to the production of the carbide, and from it of the acetylene, on a commercial scale in this country, I feel that the results of the past two years' experience will not be without interest.

In spite of extended experience, both in England and abroad, in the manufacture of calcic carbide, the details given as to its cost and the price at which it can be purchased offer the most entertaining reading, as, while the patentee and would-be seller of acetylene generating plant still talk airily of the cost of the carbide being anything from $7.50 to $35 a ton, the price at which one can purchase it nearly approaches $150. Indeed, in Paris, at the present time, there is considerable difficulty in geting it at $200 a ton; though we are informed that this is merely due to a temporary carbide famine, and that the new sources of supply will soon reduce the selling price even below $80 a ton, at which it stood before the late rise. Be this as it may, the factor which interests us is the price at which carbide can be obtained in England. The Acetylene Illuminating Company, who hold the Willson patents for the production of carbide, and also the Cowles electric furnace patents, which I believe enable them to control the manufacture of carbide in this country, have fixed their selling price at $140 per ton, and though there is no doubt that they will make contracts in considerable quantities at a reduction on this price, yet it is with the factor of the selling price to the public, and not the manufacturing price, that we have to deal.

In most cases, the possible prices quoted for calcic carbide by inventors who have been carried away by their wishes rather than by hard facts, are simply absurd, and far below the price at which the substance can be produced; and it may be of interest if I give the figures for the electric power necessary, which I myself have obtained in

practice in the manufacture of calcic carbide. Having been kindly granted the use of the electric plant erected for the manufacture of calcic carbide at the experimental works of the Acetylene Illuminating Company—a plant capable of working continuously at from 60 to 70 volts at 1,000 to 1,200 amperes—I made a series of experiments in order to determine the best proportions in which to take the ingredients from which carbide is manufactured, and find out the material made per electric horse power.

The production of carbide from lime and carbon under the influence of the heat of the electric furnace appears to take place according to the formula—

$$CaO + C3 = CaC2 + CO;$$

and in order to obtain this reaction, it would be necessary to use 56.1 per cent. of lime mixed with 43.9 per cent. of carbon. In practice, however, it must be remembered that the carbon used will either be finely powdered coke or charcoal, neither of which is pure carbon, while the lime employed will always vary in purity—such variations having, as I shall presently show, a very important bearing upon the purity of the carbide and acetylene produced from it. Another practical point also presents itself—viz., that, unless the mixture is suitably arranged, considerable variations in the amperage, and consequent loss of efficiency in the furnace will result.

Using a mixture of 60 per cent. of lime and 40 per cent. of carbon, a run lasting 3½ hours yields about 112 lbs. of fused ingot, and of this 81 per cent. was practically pure carbide—the remainder being a crust of lower value. The mixed carbides yielded 5 cubic feet of gas per pound and contained 89.2 per cent. of true carbide; hence the yield of the commercial carbide may be taken as being 32 pounds per hour. The current used was 60 volts at 1,000 amperes, or 80 electrical horse power, which gives as the make about 0.4 pound per electric horse power per hour. The result of continued experiments shows that 0.3 to 0.4 pounds per electric horse power per hour is the average yield.

The cost of the electric horse power will, of course, vary with the source from which it is obtained; and the use of steam power for generating the electricity appears too costly to be entertained unless the present electric lighting stations could see that it was to their advantage to level up their load by manufacturing the carbide under license when not employed in supplying current directly for illuminating purposes. The Acetylene Illuminating Company have, however, secured considerable water power at the Falls of Foyers, and a full installation of carbide plant is now at work there; while still further water power has been secured in a convenient position, and additional works will be erected. But it will always be the demand for, and not the cost of, the carbide which will govern the price.

The following yields of acetylene from various samples of commercial carbide that I have analyzed give an idea of the variations to be found in the article:

Swiss carbide per pound		I.	yielded 4.38	cu. ft.	of acetylene.
		II.	" 4.60	"	"
		III.	" 4.56	"	"
German carbide	"	I.	" 3.82	"	"
		II.	" 3.46	"	"
		III.	" 3.24	"	"
		IV.	" 2.43	"	"
English carbide	"	I.	" 5.24	"	"
		II.	" 4.84	"	"
		III.	" 5.04	"	"
		IV.	" 5.52	"	"
		V.	" 4.84	"	"
		VI.	" 5.32	"	"

It is evident, therefore, that there are wide differences in the commercial article; but with reasonable care in the manufacture the carbide should yield an average of 5 cubic feet of acetylene per pound.

The gas obtained from the English carbide is very pure, the chief impurity being 2 to 3 per cent. of sulphureted hydrogen, due to sulphur in the coke and gypsum in the lime; while with many of the Continental samples 6 to 9 per cent. of impurities is by no means uncommon. One of the principal and most dangerous impurities is phosphoreted hydrogen, which is evidently due to the use of phosphatic lime in the manufacture of the carbide; and also traces of siliciureted hydrogen. So bad is this with some samples, that the acetylene produced from one batch obtained from Denmark actually gave a haze when burnt for some time in a small room.

It is manifest that, if the carbide is contaminated with calcic phosphide, the action of water upon it must give rise to a certain quantity of spontaneously inflammable liquid phosphoreted hydrogen, as well as the gaseous compound, and the liquid condensing during compression or in the storage holder is a very grave source of danger. In the manufacture of carbide, no lime or coke should be used which contains more than the smallest trace of phosphates. If this point is not more carefully attended to than it is at present in some of the Continental works, serious accidents are sure to follow, while if this is done, as is the case in the manufacture of English carbide, no danger from this cause need be apprehended.

Ammonia is also found as a frequent impurity in acetylene and gives it the power of attacking copper, with the formation of an explosive compound.

In the paper I read before the Society of Arts, in January, 1895, I pointed out the ease with which the acetylene was liberated from the carbide by the action of water; and I suggested several forms of apparatus in which such decompositions might be brought about. These suggestions were followed by a rush of would-be inventors into the patent office, the literature of which has been increased to an alarming extent during the past two years by patents, many of which are characterized neither by novelty nor utility, and which, moreover, are in cases fraught with considerable danger. With the further experience which I have gained in the production and properties of this gas, I now see that many of the hints which I threw out in that paper as to the construction of apparatus would be fraught with many drawbacks, as though most of the dangers with which acetylene was then credited have disappeared into thin air, some other totally unexpected ones have taken their place, and most manufacturers of acetylene apparatus being still ignorant of them, a lively time may be expected for those who employ appliances constructed by people possessing a limited mechanical knowledge, and knowing absolutely nothing of the properties of the gas with which they are dealing. These are certain to give rise to many troubles in use, and so to retard the utilization of this beautiful illuminant.

In the generation of acetylene from calcic carbide, far too little attention is being paid to the high temperature evolved when any considerable quantity of it is brought into contact with water, and the effect which this has upon the gas. Several attempts are being made to introduce automatic machines for the generation of acetylene, on the principle of the ordinary Kipps sulphureted hydrogen apparatus. Indeed, several of them are only modified copies of this in metal. The idea of the manufacturers is evidently that the action will cease and the evolution of acetylene be stopped when the pressure of the gas drives the water back from the carbide. But this is not so, as the heat of the action saturates with water vapor the gas present, and as the apparatus cools, this re-condenses on the carbide and produces more gas, while the unchanged carbide will decompose the vapor before condensation, and even dehydrate the calcic hydrate which was formed on its surface when the water was in contact with it. The result of this is that, after the gas has once been made, no automatic arrangement will stop the slow generation of the gas from the carbide in the apparatus. When the gas is being continually used this does not matter much, as the slowing down of the evolution of the gas is sufficient to allow the consumption to catch up the make. But when the gas is turned off, if any quantity of carbide is undecomposed, the automatic generator, with its small holder, becomes an active danger, as it will either "blow" or generate dangerously high pressures.

In any form of generator where the quantity of carbide is large, the heat produced by the action of the water on the material is quite sufficient to polymerize some of the acetylene into tar-like products, which will sometimes cause trouble, and stoppages in the pipes. In any case, the high temperature causes a large amount of steam to go forward with the gas; and unless special precautions—such as using a sufficiently large holder—are taken to prevent it, some of this is carried forward to the service pipes. There is no doubt that, for the use of the gas in country houses, a holder large enough for an evening's supply should be provided, and the generators ought not to be charged with more carbide than is necessary to yield a volume of gas equal to the capacity of the holder.

The dangers of acetylene, of which a good deal has been heard lately are almost entirely dependent upon the use of impure carbide and improper apparatus. Pure acetylene has now been shown to be less poisonous than ordinary coal gas, and far less so than coal gas enriched with carbureted water gas; while the action of the pure dry gas on metals is practically *nil*. It is well known that acetylene can be resolved into its constituents by detonation, and the idea has arisen from this fact that acetylene is itself an explosive of great power. This is, however, an error, as it has been clearly shown that, when the gas is under ordinary atmospheric pressure, if detonation is started by

a charge of mercuric fulminate, the explosion only extends a few inches from the detonator; while the explosion in acetylene of acetylide of copper is insufficient to set up detonation of the gas under these conditions. This, however, only applies to acetylene under ordinary pressure, and any attempts to liquefy it by the pressure created by the evolution of the gas from calcic carbide is an extremely dangerous operation, as, if the heat of generation is added to the heat evolved during compression, an action akin to detonation is very likely to take place with the resolution of the acetylene into carbon and hydrogen. Out of the many forms of generator which have been patented in this country and abroad, there are some which, though there is no very startling novelty in their construction, afford safety in use; and intending users of acetylene apparatus should make sure that the generators they employ have been examined and certified as safe by some competent authority.

I have pointed out some of the troubles existing in the production of acetylene on a commercial scale; but, given a good form of generator, the trouble which still exists is that there are but few burners at present manufactured which can be relied upon to consume it in such a way as to develop from it its wonderful illuminating power for any great length of time without smoking; and when the burner itself starts smoking, it can be easily realized that its business capabilities are immense. For domestic illumination, a burner consuming more than 1 cubic foot of the gas per hour would have too intense a light to be practically usable, and I have found it possible to make a burner which for this consumption shall emit a light of from 32 to 34 candles, which is ahead of the duty obtained for the same consumption by any other burners I have tested. But with all burners, good and bad alike, after a certain period of perfect burning, which may extend to several hundred hours, a time is sure to arrive when the burner commences to smoke; and, as a rule, all that can be done with it is to take it out and put in a fresh one. The cause of this is that, in all burners fitted for the consumption of acetylene, the holes or slits through which the gas issues have to be exceedingly fine; and, in time, the heat of the burner causes the polymerization of some of the acetylene into liquid hydrocarbons, which, being decomposed in the hole or slit, give rise to a slight carbonaceous deposit and the growth of carbon filaments from the exit. These filaments can be easily removed when they make their appearance, but the partial stoppage in the fine aperture of the burner itself upsets the balance of the burner and causes smoking. The fact that burners can be cheaply obtained which, for a limited time, give satisfactory results, enables dealers to sell burners, and to declare that no such trouble exists. But the public who are induced to buy will soon discover the facts for themselves.

Acetylene is soluble in water and many other liquids. At ordinary temperature and pressure, 10 volumes of water will absorb 11 volumes of the gas; but unless the gas is bubbled through the water, the absorption is hardly noticeable in the case of an ordinary receiver or gasholder, as the surface of the water rapidly becomes saturated. After that the absorption is very slow; while when the whole bulk of water is completely saturated, the absorption stops. The solubility of the gas may also be largely done away with by dissolving salt in the water surrounding the holder. This, however, has a destructive action on the metal, and it is therefore better to use ordinary water as the liquid over which the gas is collected and stored.

The gas can be condensed to a liquid under a pressure of 21.53 atmospheres, or 323 pounds, at a temperature of 0° C.; while at ordinary temperatures the pressure necessary to keep it in the liquid state is from 500 to 600 pounds on the square inch. The liquefied gas can therefore be readily stored and transported in steel cylinders of the kind employed for liquid carbon dioxide. The liquid so produced is mobile and highly refractory, and when sprayed into air, the conversion of the liquid into the gaseous condition absorbs so much heat that some of the escaping liquid is changed into a snowlike solid, which takes fire on applying a light to it and burns until the solid is all converted into gas and consumed. The possibility of liquefying acetylene at pressures about those at which liquid carbon dioxide is produced so largely, enables enormous volumes of gas to be compressed into the liquid state in small wrought iron or steel cylinders; and in this condition, by means of suitable reducing valves and burners of the right construction, it may be stored and burnt. The small cylinders can also be arranged in the form of portable lamps; while for use in the country, where no gas is available, a large cylinder of the liquid gas placed in an outhouse would supply a country house with light for a very long period.

It is now well recognized that all luminous hydrocarbon flames owe their light-giving properties to fine particles of carbon liberated within the flame by various processes of decomposition, and raised to incandescence partly by the heat of the flame, and partly by the heat generated by the same actions which caused the separation of the carbon; and it is to the formation of small traces of acetylene in all hydrocarbon flames that a large amount of their luminosity is due. We should therefore expect that acetylene, when burnt by itself, would be the most brilliant of all gaseous illuminants—an expectation which is fully borne out by the results in practice. Acetylene gas when burnt gives a flame of intense brilliancy, and, owing to its richness, it can only be consumed in small burners. Under these conditions it emits a light greater than that given by any other known gas; its illuminating value, properly developed, calculated to a consumption of 5 cubic feet an hour—the average consumption of ordinary coal gas—being no less than 240 candles. It is thus seen that when acetylene is employed in suitable burners it develops an illuminating value 15 to 20 times greater than that obtained by the combustion of the same volume of coal gas. So that, for all practical illuminating purposes, a very small consumption of acetylene in the burners which practice has shown to be best suited for the purposes, does the illuminating work of a very large volume of coal gas, with the result that the air of the room is but little contaminated with products of combustion, and the excessive heating of the upper portions of the air is reduced to a minimum.

The following table contrasts the products of combustion evolved from London coal gas when consumed in various forms of burners, and furnishing an illumination of 48 candles, which may be presumed to be the quantity of light required in a fair-sized London dining room. Contrasted with this is the amount of the products of combustion which acetylene would evolve in giving the same amount of light; while, to make the meaning clearer, I have added the number of adults who would exhale an equal amount of carbon dioxide in the same time.

Burner.	Gas Consumed.	Carbon Dioxide.	Adults.
Flat flame No. 6...	19.20	10.10	16.80
" No. 5...	22.90	12.10	20.00
" No. 4...	25.30	13.40	22.30
"London" Argand	15.00	7.90	13.10
Acetylene.....	1.25	2.50	4.50

If we obtained the same amount of light from paraffine lamps, the carbon dioxide evolved would be equivalent to 22.5 adults; while as far as carbon dioxide goes, you might as well invite 32.7 more guests to dinner as use 48 sperm candles to supply the needed illumination.

It has been said that the danger of an explosion from leakage of acetylene is far greater than with coal gas. This is, I think, a mistake. Mixtures of air and acetylene are explosive over a slightly wider range than is the case with mixtures of coal gas and air. But it must be remembered that, if a leakage were caused by a tap being left on, the largest acetylene burner would probably only pass 1 cubic foot of gas per hour, while an ordinary No. 4 or No. 5 union jet burner would pass from 5 to 6 cubic feet of coal gas in the same period. From this cause, therefore, it would be far more dangerous than acetylene, and if the leak were from a small crack or a defective joint in a pipe, the rate at which the gases diffuse out would be dependent upon their specific gravity. Coal gas has a specific gravity of .4, as against .9 for acetylene. So that through a crack or fissure of the same size only two volumes of acetylene would escape, while three volumes of coal gas would find their way into the air—a difference in rate which would more than cover the slight variation in the limiting proportions of the explosion; and very little experiment will clearly prove that acetylene cannot in any way be looked upon as more dangerous to property than coal gas.

The field for acetylene at the present time is simply enormous, as not only is it specially adapted for the lighting of country houses and small villages and towns where no coal gas supply at present exists, but it will probably in the near future take the place of existing forms of lighting in railway carriages, tramcars, floating buoys, etc.; while as an auxiliary to the electric light for lighthouses, search lights, and coast defence, it will, I believe, be of the greatest possible value. Should any cheapening of the production of calcic carbide take place, there is even a larger sphere of usefulness awaiting it—a sphere, moreover, in which the troubles found in the consumption of acetylene *per se* will entirely disappear. There are many places in England where the cost of good gas coal makes coal gas prohibitive in price, while on the Continent these troubles exist to a far greater extent; and if it were commercially possible to use acetylene as an enricher of a cheap fuel gas, an enormous field would be opened up.

When acetylene was first rendered a commercial possibility, numbers of experiments were made in order to see if this could not be done. But the results were most discouraging, as, instead of each 1 per cent.

of acetylene added to the diluting gas giving a value of about two candles, it was found that it was necessary to add something like 10 to 15 per cent. before the mixture became endowed with any luminosity at all; and that with water gas an admixture with 20 per cent. of acetylene was necessary to give anything approaching a 20-candle gas. With a poor coal gas, however, the enrichment value of the acetylene gives better results, but still not sufficiently good to hold out any great hopes of acetylene replacing oil as a means of enrichment. This curious phenomenon of high illuminating value, when the gas was consumed *per se*, being reduced so enormously when it was used as an enricher, led me to make a long and exhaustive series of experiments on the causes of this being so. I have now found the reason for this apparent anomaly, and also a way in which it can be obviated, with the result that it would be perfectly easy, by a simple and rapid process, to make a fuel gas costing from 16 cents to 25 cents per 1,000 cubic feet, and by the addition of 10 per cent. of acetylene to raise this to an illuminating value of about 20 candles—a result which, given cheap carbide, would open up an enormous field for the employment of acetylene gas.

For use in country houses or generally for domestic illumination, it has been proposed to dilute the acetylene by means of air, apparatus for making the mixture of acetylene and air having been tried both in this country and in America. But so wide is the explosive range of mixtures of this character, that any such appliances would be of the most highly dangerous nature; and should anyone, from want of knowledge, be willing to adopt them, I should expect that the insurance companies would firmly prevent their introduction, by declining to insure buildings in which such methods of illumination were adopted. It is perfectly easy to make a mixture of acetylene and air which will burn with fine effect and a non-smoking flame. But the apparatus employed to give such a mixture is always liable to get out of order; and an alteration in the proportions in which the gases were mixed might lead to the most disastrous results. A safe method of attempting this is to make an acetylene burner in which (in the burner itself) the gas escaping through an injector shall draw in the necessary amount of air for its consumption. But all the burners I have seen on this principle have the drawback of requiring a high pressure of gas in order to work satisfactorily; and even then the results obtained from them are of a very variable character, and smoking is by no means an unknown thing.

Any other diluent than air would require special apparatus for its production, and this would do away with the charm of simplicity in manufacture which renders acetylene so well adapted for illuminating country houses. It is well known that the carbides of some metals give, on decomposition by water at a slightly elevated temperature, other hydrocarbons, and in some cases mixtures of hydrocarbons and hydrogen. If such carbides are mixed with the calcic carbide, the heat produced by the decomposition of the carbide by water and the slaking of the lime cause the decomposition of the other carbides present, and a mixture of gases is evolved which can be made to approximate to the composition of coal or oil gas. Taking, for instance, the carbide of calcium and aluminum, a mixture of marsh gas and acetylene is obtained, which, while possessing magnificent illuminating power, can be consumed without fear of smoking. If the carbide of manganese be used instead of the carbide of aluminum for mixing with the calcic carbide, a mixture of marsh gas, hydrogen and acetylene can be obtained; and possibly when the best method of forming carbide has been arrived at, it will be found preferable to use mixed carbides of this character rather than calcic carbide *per se*.

Comparative experiments have been made on the utilization of acetylene and oil gas for railway carriage lighting. It gives for this purpose a most brilliant illumination, as, the source being well above the range of vision, the carriage is flooded with light without any irritation being caused to the eyes. I have traveled in a carriage lighted in this way by the Acetylene Illuminating Company on one of the principal lines; and the ease with which the halfpenny papers could be read and trains looked up in a "Bradshaw" throughout the whole journey indicated that the light was amply sufficient in every part of the carriage. For railway carriages, compressed oil gas, and not coal gas, is employed; and in order to test the relative values of acetylene and this illuminant I obtained a cylinder of Pintsch's gas as used on the Southeastern Railway, and consumed it in a lamp and fittings of the same character as those employed on the line. This gas, when burnt in the burner most suited for its consumption, gives an illuminating value of 52 candles, or 10.4 candles per cubic foot of gas consumed.

The following table gives the values obtained by burning it with a double and a single burner in a carriage lantern fitted with a reflector:

Pintsch Gas.

Position.	Double Burner. Gas Rate, 1.8 c.f. per Hour. Candle Power, Mean of Tests.	Double Burner. Pressure, 1.5 Inches. Candle Power per Foot.	Single Burner. Gas Rate, 1 c.f. per Hour. Candle Power, Mean of Tests.	Single Burner. Pressure, 1.25 Inches. Candle Power per Foot.
Horizontal	18.86	10.477	8.56	8.56
5°	18.86	10.477	8.56	8.56
10	18.62	10.344	8.56	8.56
15	18.06	10.030	8.51	8.51
20	17.60	9.770	8.34	8.34
25	17.46	9.700	8.26	8.26
30	17.42	9.670	8.16	8.16
35	17.40	9.660	7.94	7.94
40	17.22	9.560	7.80	7.80
45	16.04	8.900	7.54	7.54
50	15.04	8.350	7.30	7.30
55	14.08	7.800	6.96	6.96
60	13.08	7.260	6.50	6.50
65	12.22	6.790	6.04	6.04
70	11.50	6.390	5.53	5.53
75	10.00	5.550	4.96	4.96
80	9.00	5.000	4.48	4.48

A cylinder of acetylene made from calcic carbide by the action of water was pumped by Messrs. Pope, and was then tested, when burning from a 1 cubic foot burner, and also from a ½ cubic foot burner in Pope's lantern, fitted with Thomas's reflector, the results were as follows:

Acetylene Gas.

Position.	Large Burner. Gas Rate, 1 c.f. per Hour. Candle Power. Mean of Tests.	Large Burner. Pressure, 2 Inches. Candle Power per Foot.	Small Burner. Gas Rate, 0.5 c.f. Per Hour, Candle Power, Mean of Tests.	Small Burner. Pressure, 2 Inches. Candle Power per Foot.
Horizontal	26.00	26.00	8.60	17.20
5°	26.00	—	8.60	17.20
10	27.00	—	8.60	17.20
15	27.20	—	8.60	17.20
20	27.60	27.60	9.08	18.16
25	27.40	—	9.04	18.08
30	27.10	—	9.00	18.00
35	26.90	—	9.28	18.56
40	25.90	25.90	9.08	18.16
45	25.00	—	8.76	17.52
50	23.00	—	8.54	17.08
55	21.10	—	8.00	16.00
60	20.10	20.10	8.00	16.00
65	18.20	—	7.50	15.00
70	15.65	—	7.30	14.60
75	14.30	—	6.50	13.00
80	12.20	12.20	4.50	9.00

The illuminating power of the cubic foot burner was in this case only 26 candles on the horizontal, instead of 32 candles as in a previous experiment with pure acetylene; and as this loss of light seemed greater than one would expect by absorption by the glass globe, the gas was analyzed, and found to contain 10 per cent. of air. This is, of course, due to the cylinder having been filled for experimental purposes—the difficulty of washing the pumps, pipes and cylinder free from air for a single operation being very great; whereas, in regular working, 2 per cent. of air or other impurities would be about the limit. This being so, it seemed fairer to make a fresh sample of the gas, and repeat the observations under conditions similar to those which would exist in practice. The gas contained 97.8 per cent. of acetylene; and the results obtained with the cubic foot burner and a pressure of 2 inches in Pope's lantern were as follows:

	Candle Power of Gas Consumed at 1.05 Cu. Ft. Rate.	Candle Power per Cu. Ft. of Gas Consumed.
Horizontal	32.00	30.47
5°	32.00	30.47
10	32.00	30,47
15	32.00	30.47
20	33.00	31.42
25	34.00	32.38
30	33.00	31.42
35	32.50	30.95
40	32.00	30.47
45	31.60	30.09
50	30.00	28.57
60	28.00	26.66

An ordinary railway carriage is from 5 feet to 5 feet 9 inches in in width, and 8 feet from door to door; while the flame is, as a rule, about 7 feet from the floor. The seats being from 15 to 17 inches in height, this would bring the paper or book a passenger was trying to read as nearly as possible 3 feet from the floor. This gives an angle of from 45° to 50° as the important one for the rays that are to be utilized. These results are also confirmed by the tests made by engineers on some of the principal lines, who find that, for railway carriage illumination, acetylene is from four to five times as valuable as the oil gas usually employed; and there is no doubt that this brilliant illuminant is destined to play a most important part in our future illumination.

The lecturer, in conclusion, expressed regret that the time allotted to him by the Society had only enabled him to deal very inadequately with this part of his subject.

On Some New Forms of Gas Generators for Laboratories.

[By Mr. Thomas H. Norton, of the Chemical Laboratory of the University of Cincinnati.]

Improvements in the construction of the automatic generators, for the gases most frequently used in our laboratories, are always welcome. The following three types, which I devised some time since, have been subjected to prolonged trial in the laboratory of the University, and have given such satisfactory results that a detailed description would seem worthy of publication.

In Fig. 1 is represented a gas generator for hydrogen, hydrogen sulphide, etc., which differs in several details from well known types of the same general outline. It is constructed of glazed earthenware, and is easily made in our ordinary potteries. *A*, the outside container, is provided with handles on the outside, and is ordinarily 60 cm. in height. Its chief peculiarity is the presence on opposite sides of the inner wall, of the shoulders *DD*, each about 4 cm. wide and slightly concave on the lower surface. *B*, the gas reservoir, is of the ordinary bell jar construction, with orifice at the top for the introduction of a perforated stopper and outlet tube. It is provided with projecting shoulders 3 cm. wide, corresponding to *DD*, and at such a height that they barely slip beneath the latter. At the bottom are frequent circular perforations, 1 centimeter in diameter, to allow of the easy passage of the acid charge. The recipient *C*, designed to hold zinc or any solid charge, is provided with a loose disc perforated with many fine openings and rest ing upon the shoulder of the constriction. Beneath the constriction are perforations corresponding to those in *B*. A strong copper wire or rod, passing through the perforations of both parts of the apparatus, holds *B* and *C* in their mutual position to each other.

The working of the generator is exceedingly simple. *C* receives its charge of zinc, marble or ferrous sulphide. *B* is placed over it. The copper rod is passed through the perforations at the bottom. *B* with *C* is then introduced into *A*, and turned until the shoulders of *B* are beneath *DD*. *A* is then filled with the acid charge. The buoyancy of *B* is partly overcome by the rigid attachment of *C*, and entirely prevented by *DD*. Gas can be drawn off as desired, by opening the tap at the outlet tube. When, as naturally occurs, the acid in the lower portion

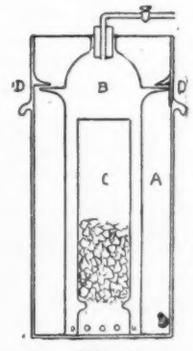


Fig. 1.

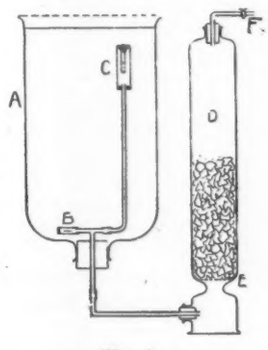


Fig. 2.

of the generator becomes weak and the evolution of gas sluggish, the exit tap is closed, *B* is turned slightly so as to be free from *DD*, and is then lifted, by grasping the neck, along with the holder *C*, until entirely above the surface of the acid. Both are then plunged to the bottom of *A*, and a few repetitions of this churning movement renders the acid charge of uniform strength.

This style of generator has rendered excellent service. For example, one 60 centimeters in height easily supplies all the hydrogen sulphide required by a class of 30 in qualitative analysis. The special advantages

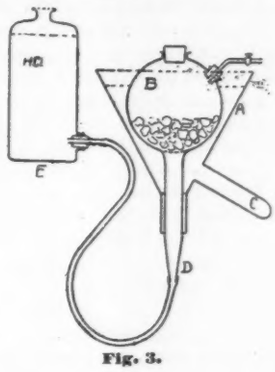


Fig. 3.

of this generator are to be found in the ease and simplicity with which the buoyancy of the gas reservoir is overcome and the acid charge is maintained at a uniform strength until practically exhausted.

In Fig. 2 we have a less compact and less transportable form, but one which maintains the uniform strength of the acid charge until it is exhausted, without the need of special manipulation, as described above. It is particularly designed for use where small amounts of hydrogen sulphide are in constant requisition, as in the laboratory for qualitative analysis, and it has the advantage of being capable of easy construction from the glassware found in any well equipped laboratory. *A* is a capacious tabulated bell jar inverted and resting upon either a tripod or the ring of an ordinary support. The perforated stopper in the neck is traversed by a -tube. One terminal of this tube is connected with a simple Bunsen valve *B—i. e.*, a piece of rubber tubing, closed at one end and provided with a clean cut slit in the rubber some 2 cm. in length. The other terminal of the -tube is connected with *C* in the upper portion of *A*. The attachment *C* is similar to that frequently introduced between suction pumps and filtering flasks. It is the reverse of *B* in its construction, allowing a current of liquid to enter from the outside through the rubber valve. *A* serves as a reservoir for the acid charge.

The third external exterminal of the T-tube is connected with the tubuluos of the lower portion of an ordinary lime drying tower *D*, preferably of the largest constructed. *D* serves as the recipient for the ferrous sulphide, etc., which may be used, and is provided with a perforated disk at *E* and the outlet tube *F*, the latter on a level with the top of *A*. The working of the generator is exceedingly simple. *A* is charged with acid and *D* with, say, ferrous sulphide. When *F* is opened the acid flows through *C* into *D*. When *F* is closed the pressure of the gas evolved forces the acid back into *A* through *B*. The result is that the supply of acid furnished *D* is always from the top of the reservoir *A*, and hence stronger than that found in the lower strata, which are successively of greater specific gravity, weaker in acid and richer in saline matter, as the bottom is approached. The arrangement permits of a very complete utilization of the acid. When the current of gas is in continuous demand, and evolution becomes sluggish, it is necessary to close the tap at *F* for a short time until the liquid in *D* is driven back into *A*.

Care must be exercised in constructing the valve at *C*, so that it will yield to a very slight pressure. To effect this the slit in the rubber should be at least 2 cm. in length. When the apparatus is used exclusively for the evolution of hydrogen sulphide to be employed in qualitative analysis, it is desirable to have beyond *F* some device which regulates uniformly the strength of the current of gas and keeps it within the limits of easy absorption. In practice this has been accomplished most simply by introducing into the rubber tube attached to *F* a short piece of glass tubing, one end of which is drawn out so as to form a very narrow opening.

Essentially the same principle for the control of the strength of the acid charge is to be found in the generator devised recently by Professor Harris. In consequence of the costly character of the latter, due largely to the use of valves of elaborate construction, the form of generator just described may be welcome to many on account of its simplicity and inexpensiveness.

An automatic chlorine generator based upon the use of manganese

dioxide, has long been desired. In Fig. 3 is shown such a generator which for six years has rendered satisfactory service, both on the lecture table and in the laboratory. The essential parts only are outlined without the accompanying supports. *A* is a copper funnel, provided with a hollow projection *C*, on one side, perfectly similar in make to the funnels used for hot water filtration. It can be advantageously replaced by the more graceful and modern type of aluminum funnel, resting in a ring burner. The reservoir *B* is of glass, and is an article of current manufacture, obtainable from all dealers in chemical glassware. The long, tapering neck is tightly fastened in the neck of the funnel by means of a section of rubber tubing. A large opening at the top, closed by a rubber stopper, serves for the admission of the charge. In a smaller tubulure on the side is a perforated rubber stopper with outlet tube and tap. The funnel with its reservoir is held firmly in a support, so that the end of *C* is about 2 cm. above the top of an ordinary burner. A perforated plate is introduced into *B* so as to prevent solid matter from falling into the narrow neck. The latter is connected at *D* with a large tubulated bottle *E*, which serves as a reservoir for hydrochloric acid, and is attached to a support so that it can be raised or lowered at will. When in use *B* is filled to two-thirds of its capacity with manganese dioxide, large lumps alone being used, as powdered mineral may easily cause a stoppage of the connections. *E* is filled with hydrochloric acid and raised to a level slightly above the top of *B*. Water is poured into the funnel *A* until it is nearly full, and a lamp is placed under *C*. As soon as the temperature has reached about 80°, a very small flame suffices to maintain the activity of the generator. When the exit from *B* is open, the acid enters and the evolution of chlorine continues until checked by closing the tap, when the acid is driven back into *E*. A slight agitation of the latter before opening the tap serves to prevent the accumulation of a stratum of weak acid at the bottom. It is advisable to lower the reservoir *E* when a current is not required, so as to avoid pressure and any possible escape through minute leaks. In practice it is also found desirable to connect the opening of *E* by a flexible tube with a bottle of caustic soda solution, the tube terminating at the surface of the solution. This prevents any escape into the surrounding air of chlorine, with which the contents of *E* are soon saturated. When thus arranged a current of the gas can be taken at will from the generator, the sole condition being the maintenance of a small flame beneath *C*. The manifold advantages of such a device, especially for the lecture table, will be appreciated by all who attempt an extended series of experiments with chlorine. As described above, the generator can be readily constructed from pieces of apparatus ordinarily found in a well equipped laboratory. I have found a generator in which the reservoir *B* contains 1,500 cc., a very convenient size for use in the lecture room.

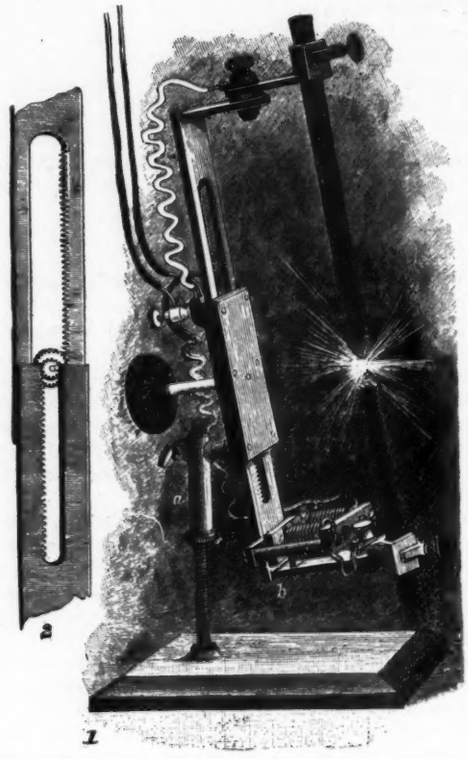
Hand Feed Electric Lamp for Lanterns.

Mr. George M. Hopkins, writing to the *Scientific American*, says that while a good automatic lamp is undoubtedly preferable to a hand lamp for uses necessitating the absence of the operator from the vicinity of the lamp, it is certain that an ordinary hand lamp is not to be despised, and when the hand feed is supplemented with a magnetic device for striking the arc, the difference between the two types of lamps referred to is not to the disadvantage of the hand lamp when the latter is used in a lantern or for some other purpose which permits the operator to remain near the lamp, so that he may adjust it at intervals of about four or five minutes.

The lamp shown in the illustration has been used for an entire evening without a flicker. The upper, or positive, carbon is cored, and the lower, or negative, is solid, hard Carre carbon.

On the threaded rod extending upward from the base plate is placed the sleeve *a*, which is connected with the slide holder so as to have a slight inclination, as is usual in lamps for lanterns, in order to expose more of the face of the crater of the upper carbon. The slide holder contains two slotted slides; the one holding the upper carbon being 7½ inches long, the one holding the lower carbon being 5½ inches long, each being 1¼ inches wide. To the lower end of the lower slide at *b* is pivoted an arm extending outwardly and supporting the lower carbon holding socket. To the arm near the joint thereof is secured an upwardly extending stud carrying an armature. An electro-magnet having an elongated yoke is supported in front of the armature by brass tuds attached to a brass cross arm fixed to the lower slide. A curved brass spring fastened to the armature bears on the poles of the magnet and serves the double purpose of throwing the armature back and the carbon upwardly when the armature is released, and of preventing the armature from sticking to the magnet.

The upper carbon holding slide is provided with a fixed arm extending outwardly and supporting an insulated carbon holding socket. These sockets are connected with their respective arms by bolts, which are surrounded with soapstone insulators provided with flanges which separate the sockets and the arms. The heads of the bolts are insulated by means of mica washers. The holes through which the bolts extend are made oblong to permit of adjusting the carbons in a way to secure the best results, that is, by arranging the point of the lower carbon so



that it will be slightly in front of the axial line of the upper carbon when the lamp is in operation.

In the slots of the carbon holding slides are secured racks, which engage pinions on the spindle journaled in the slide holder (Fig. 2). The pinion for the lower carbon slide has half as many teeth as there are in the pinion for the upper slide, so that when the spindle is turned by the rubber hand wheel the carbons are moved in proportion to their relative consumption.

To an insulating strip attached to the back of the slide holder are secured two binding posts for receiving the wires connecting the lamp with the current supply. One binding post is connected with one terminal of the magnet, and the other terminal of the magnet is connected with the lower carbon socket. The other binding post is connected with the upper carbon socket.

The magnet is wound with coarse wire (No. 16 or No. 14), and the armature is adjusted to pull down the lower carbon about one-eighth of an inch. The carbon holding sockets are formed of square brass tubing, with a screw at one angle which forces the carbon toward the opposite angle, and thus centers and aligns the carbons.

The Edison direct current is suited to this lamp when about 15 ohms resistance is introduced in series with the lamp. A suitable range of current is 8 to 12 amperes.

The great advantage of the arc striking device is that, after the carbons touch, the arc is instantly formed of the right length, thus saving the trouble of any fine adjustment by hand, and avoiding the possibility of any long continuance of a heavy current on the circuit. A very slight turn of the adjusting spindle, once in about 4 minutes, insures perfect steadiness. It is well to form a habit of thus regulating the arc after each change of slides. The illustrations are approximately one-third size.

Aluminum Bronze Seamless Tubing.

In a paper by Mr. Leonard Waldo, Secretary of the Waldo Foundry Company of Bridgeport, Conn., read before the last meeting of the American Society of Mechanical Engineers, the author remarked that the so-called alloys of copper and aluminum must be considered as radically different from the various metallic mixtures of copper, zinc, tin, nickel, manganese and lead which have made the bulk of the cop-

per alloys of commerce. There are, as is well enough known, certain chemical compounds among these last-mentioned alloys. In the aluminum bronzes or aluminides of copper there is no commercial method of separating the two constituents.

The result of the chemical union of aluminum and copper is the strongest of the copper compounds or alloys. Wire is readily drawn from it with a tensile strength of 180,000 lbs. per square inch.

But there are points in which aluminum bronze seems mechanically superior to any steel. It cannot, at present, be tempered, but it does not seem to show any change in the nature of crystallization under stress or shock. Thin, soft ribbon may be indefinitely coiled and uncoiled or run over rollers. A bar may be struck indefinitely upon one end. A rifle firing pin was struck over 120,000 blows without apparently changing its molecular condition. It can be made of all degrees of hardness, and its strength and percentage elongation varied from 40,000 to 100,000 lbs. per square inch, and from 70 per cent. to 1 per cent. in 10-inch bars. As an illustration of this combination of strength with ductility, I cite the fact that aluminum bronze cartridges made for the new small caliber low-trajectory rifle were fired for more than 90 consecutive rounds, charged with smokeless powder, at the Frankford Arsenal for a firing test. Added to these mechanical values are the chemical resistance to corrosive influences, and the small electric potential of the combined aluminum and copper. The non-corrosiveness is only excelled by that of the noble metals; and the low, almost zero, electric potential of the aluminum bronze gives it a value in structural engineering which peculiarly fits it for acid industrial works or water tube boilers and condensers. This value has already been tested on a large scale in underground tide water retaining bolts in our seacoast batteries and in sulphite pulp mills and the electrolytic vats of large copper refineries. As its cost is reduced by improved methods of working, it is finding its way into many uses where steel or iron has a short life from rust, inability to resist corrosion, or lack of density and strength.

It has long been evident that aluminum bronze was an ideal metal for drawn tubes; but serious difficulties presented themselves at every stage of production, from the ingot down. It was my belief that the Mannesmann or some kindred process presented the most feasible solution of getting the cylindrical ingot in a sufficiently economical way, and after the ingot was obtained that some plant capable of cold-drawing the higher grades of steel was necessary to produce the finished tube. Experiment had shown that aluminum bronze was not to be economically worked, or even worked at all with many grades, on draw benches originally planned for copper or brass. The hardness and high tensile strength combined were found to be destructive to the dies used in the best hydraulic benches for brass and copper. It remained, therefore, for the combination of the casting plant of the Waldo Foundry, under the direction of its superintendent, Mr. E. S. Sperry, to furnish the solid billet; for the newly-introduced Mannesmann plant at the rolling mills of Benedict & Burnham at Waterbury, under the superintendence of Mr. Charles S. Morse, to convert the solid ingot into a cylindrical tube; and for the new Pope Tube Works, built to cold-draw the nickel and other strong steels, under the superintendence of Mr. H. H. Eames, to convert the cylindrical tube billet of the Mannesmann process into the finished tube for the market. To these three gentlemen is due the success of the process.

The process of making the solid aluminum-bronze ingot has not yet been described. The system of solid hot tubular ingot-rolling known as the Mannesmann process is outlined in some detail at page 384 of the "Transactions, American Institute of Mining Engineers," Vol. XIX., 1891. The Benedict & Burnham Co. have introduced benefiting changes in the details of the process there described, and the Waterbury plant is a model of its kind. From one to two minutes is the time required to reduce a solid 3-inch billet to a cylindical forging ready for the draw bench.

After leaving the Mannesmann rolls the cylindrical aluminum bronze ingots were given several passes on the draw benches at Benedict & Burnham's, to lessen their size to a point where they could be taken by the Pope Company's benches, as at that time completed, the larger Pope Company's benches not yet being in place.

The new hydraulic cold-drawing plant of the Pope Tube Works is driven by two triple-expansion, single-acting Riedler pumping engines rated at 500-horse power each, but which can work up to 1,000-horse power each. The arrangement is designed by E. D. Leavitt, and an idea of the total efficiency made be had from the fact that 1-horse power is obtained for somewhat less than 12 lbs. of steam with 135 lbs. initial pressure. These engines work through two hydraulic accumulators having 16-inch rams, and working the 8 and 6-inch draw benches with a maximum pressure at the benches of 1,280 lbs. per square inch.

Aluminum-bronze tubes require frequent annealing during the process of drawing, and this is especially true of the higher compounds, such as Cu_4A, which are as difficult to draw as nickel steel.

It is known that, up to the limit of commercial temperatures—say 400° to 500° F.—that aluminum bronze retains its initial strength. In this respect it shows its great superiority to ordinary brasses and bronzes.

Table I. gives the chemical analysis and the tests of the best brass tubes the market now affords, together with the tests of the same size tubes of open-hearth Swedish steel and a low aluminum-bronze—about Cu_4Al, or a 4½ per cent. bronze.

TABLE I.—*Tests of Tubes at Ordinary Temperatures. Cold Drawn and not Annealed.*

	A. Government Brass Tube. Per Cent.	C. Ordinary Brass Tube. Per Cent.	S. Swedish Open-Hearth Steel. Per Cent.	P Aluminum Bronze, Cu_9Al. Per Cent.
Analyses Pope Mfg. Co.'s Laboratory, H. Souther, Engr. Tests, Nov., 1896.	[1]59.86	[1]67.58	[5]0.420	[1]95.79
	[2]39.82	[2]31.67	[6]0.031	[10]4.35
	[3]0.35	[3]0.85	[7]0.500	[3]0.05
	[4]0.013	[4]0.01	[8]0.031	—
	—	—	[9]0.110	—
	—	—	[10]0.007	—
	Inches.	Inches.	Inches.	Inches.
Outside diameter.....	1.502	1.5000	1.504	1.491
Inside diameter.....	1.348	1.332	1.342	1.311
Area in square inches	0.38692	0.39584	0.3427	0.42157
Gauge length.....	10.	10.	10.	10.
	Pounds.	Pounds.	Pounds.	Pounds.
Yield point.....	*	63,100	64,200	68,700
Strength per sq. in...	77,900	81,900	79,300	96,000
Elongation in 10 ins .	5.4 p.c.	9.3 p.c.	5.4 p.c.	4.9 p.c.

1. Copper. 2. Zinc. 3. Lead. 4. Tin. 5. Carbon. 6. Phosphorus. 7. Manganese 8. Sulphur. 9. Silicon. 10. Aluminum. *Not defined.

Table II. shows the effect of heating the aluminum bronze tube of Table I. to a bright red and then plunging it into water. The ultimate strength of 96,000 pounds per square inch and 4.9 per cent. elongation becomes changed to about one-half this strength, 47,600 pounds, and to 13 times the per cent. elongation. This ratio of change is at its maximum in the low compounds, and reaches its minimum in the high compounds at about Cu_4Al.

TABLE II.—*Tests of Tubes at Ordinary Temperatures. Cold Drawn and Annealed at a Red Heat.*

	Aluminum Bronze, Cu_9Al.
Outside diameter	1.625 inches.
Inside diameter	1.415 inches.
Area in square inches	0.508 sq. inches.
Gauge length	10 inches.
Yield point	24,200 pounds.
Strength per square inch	47,600 pounds.
Elongation in 10 inches	64.9 per cent.

Natural Waters and their Effects in Steam Boilers.

By MR. GEORGE W. LORD, in *Electrical World*.

It is well known to all competent observers that the usual system of boiler management as practiced in the average power and lighting plant to-day is accompanied with a great waste of fuel and much wear and tear as regards its boiler equipment. Further, that comparatively little attention has been paid to this matter either from habitual indifference to its occurrence or from want of information as to causes. Even in the best organized and conducted plants this condition is known to generally prevail, and it is difficult to assign any intelligent reason why this is so, yet it is manifest that any neglect or abuse of the steam boiler equipment must directly and greatly affect the economical management of any power plant, its prosperity and dividend-paying power. The prodigious amount of study, labor and profound thought devoted by mechanical experts to the perfection of modern types of boilers should stimulate and encourage boiler owners to treat these beneficent inventions with the most painstaking and conscientious management, so as to develop their high proved evaporative and economic powers. It may be said that in the great majority of power and lighting stations, however, a saving of from 10 to 25 per cent. can easily be attained in the cost of operation and maintenance of steam boilers, would their proprietors only show a greater disposition to observe some of the fundamental principles underlying efficient boiler management. One of the chief factors to be sought in the promotion of economical boiler service is the attainment of a supply of pure and natural water; if this

is overlooked endless trouble, annoyance and expense will inevitably follow from boiler incrustation, perhaps associated with corrosion and wasting away of the material which, more than all other causes combined, handicaps the usefulness of steam boilers, leads to explosions and consigns them, long before their time, to the scrap heap. A little calculation will show that a 100-horse power boiler, working 10 hours a day and 300 days a year, and evaporating say 15 pounds of water per hour for each horse power developed, and allowing 30 grains of solid matter in solution, the quantity of water evaporated will be 4,500,000 pounds, or 540,000 gallons, and the amount of solid matter 2,314 pounds, or a little over a ton. This collected matter would, of course, exist in a boiler were it not removed regularly. All waters are more or less impregnated with dissolved and suspended impurities, and include common salt, sulphate of lime and several other constituents of rocks. When such waters containing dissolved and suspended impurities are fed to steam boilers, the fixed and non-volatile nature of these substances insures their remaining behind in the boiler, and where subjected to high temperatures of heat, will finally become baked and firmly attached to the tubes and the shell, forming boiler scale, which prevents the water from coming into contact with the iron, and by resisting and obstructing the passage of heat to the water not only cause a great loss of fuel, but imperil the boiler parts by causing bulging, blistering and bagging, leading also in a large degree to boiler explosions.

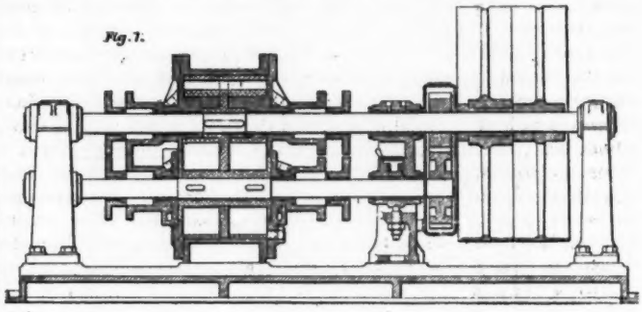
The extent of wasted energy brought about by incrustation is generally not appreciated. A scale of only $\frac{1}{16}$ of an inch in thickness will interpose so much heat between the iron and water as to require 12 per cent. more fuel than when the boiler is clean; while a scale of one-fourth of an inch in thickness will require an expenditure of more than double this quantity of fuel to perform the same duty as a boiler with a clean shell and tubes.

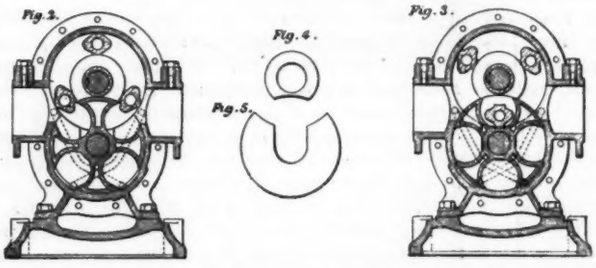
There is no more perplexing problem confronting power-station owners than the method by which to combat and prevent this condition. It is true the market is flooded with many articles containing 50 to 60 per cent of harmful tannic acid mixed with grape and cane sugars, which generate acetic acid in the boiler water under steam, and further mixed with caustic alkali. Such materials are more harmful than boiler incrustation itself. Fluid vegetable extracts, which always contain predominating quantities of acids, mostly tannic acids, should never be used. In fact, all fluid articles should be handled with grave suspicion. They contain a large quantity of gummy and resinous materials, which interfere with the operation of the valves and other boiler accessories.

The writer has found that the most successful chemical reagents employed include such chemicals as sodium fluoride, sodium tannate, tri-basic sodium phosphate and barium salts, etc., which should be carefully compounded together according to the analysis of the water to be purified. These salts chemically appropriate the acid part of the basic earths forming boiler incrustation and by converting them into soft snow-flaky precipitants which are held in suspension in the boiling currents of water prevent sedimentation and the formation of scale. Besides, these reagents will neutralize any acids present in the feed water, which neutralizing action is of the utmost importance and is the only method by which to prevent corrosion. Of late years distilled mineral oils have been used a great deal, but as the evils attending their use are gradually becoming known, they are rapidly falling into disuse and disfavor. Aside from the danger incident to the presence of these inflammable oils, they invariably promote bad leakage of the boiler parts, the burning and crystallization of the material and the overheating of the plates. Some engineers claim that when oil is intelligently used these evil effects can be obviated, but in the opinion of the writer their use is attended with so many bad results that they should be abandoned. These hydrocarbon oils are very penetrating as may be seen in the removal of rust from tools, and in penetrating the boiler joints they so lubricate these parts that the forces of expansion and contraction soon cause them to leak badly, thus bringing conditions which are a bane to all careful engineers. Oil also tends to throw down the scale in large fragments which accumulate over the furnace plates, producing over-heating, bulging and blistering, while seriously obstructing the circulation currents. Oil, when it works its way back of boiler scale, detaches the scale which falls off, thereby bringing into instantaneous contact the cold water in the boiler and the hot overheated places on which the scale was attached, resulting in such a dangerous molecular contraction on this part of the plate that it is liable to fracture. Every case differs and every remedy must differ likewise, so that it is only by advising with reliable experts that the best effects can be obtained.

The Piftin Rotary Pump.

The illustrations show a form of rotary pump that is finding considerable favor in European markets, the manufacturers of which are Messrs. Morris & Bastert, 211 Upper Thames street, London, E. C. The construction embodies novel features, in that, in the first place, only one of the two rotating pieces does any work, the other being totally unloaded and merely serving to prevent leakage. Further, tightness is secured without actual contact between the two revolvers, there being, in fact, a clearance between them of as much as $\frac{1}{4}$ inch. In each case the actual joint is between the revolver and some fixed part of the casing, an arrangement which permits of the use of large surfaces of contact, which in turn simplifies the prevention of leakage. A longitudinal section through the pump is shown in Fig. 1, whilst cross sections showing two different positions of the revolvers are shown in Figs. 2 and 3. The lower revolver, it will be seen, is driven from the upper by means of gearing, but as the latter has only to transmit power sufficient to overcome frictional resistances, it is subject to but little wear.





The working revolver is the upper one, which, as will be seen from Figs. 2 and 3, carries three pistons, mounted on a central disc, and bearing at their inner surfaces against a fixed sleeve, and at their outer surfaces against the inner cylindrical wall of the pump casing. The lower revolver carries four arms, of which the outer surfaces form portions of a single cylinder, and as these are the only portions requiring machining, they can be simply and cheaply prepared. This outer cylindrical surface, as shown in Fig. 2, fits into a crescent shaped gap cut in the sleeve surrounding the spindle of the upper revolver. This sleeve is shown separately in Fig. 4. The fluid under pressure can only leak back past the two upper pistons or through this joint, which, as will be seen, has ample width. Leakage past the edge of the central disc of the upper revolver is prevented by the horseshoe shaped piece shown in Fig. 5, which can be seen in place in Fig. 2. The pressure on the lower revolver is balanced by the cross pipes shown dotted in Figs. 2 and 3, from which it will be seen that opposite segments are always subjected to the same pressure. The makers state that bits of wood and pebbles can easily pass through the pump, and that for lifts up to 250 feet it gives remarkable efficiency.

On the Behavior of Coal Tar Colors Toward the Process of Digestion.

[By Mr. H. A. Weber, Ohio State University.]

It is very well-known that the coal tar colors have come into general use for coloring confectionery and other articles of food and drink. In fact they have almost completely superseded the vegetable colors, which have been used from time immemorial for a similar purpose. The indiscriminate use of these colors, some of which are derived from bodies of a decidedly poisonous nature, has often been regarded with suspicion by persons who are interested in public health. On account of the uncertainty existing in regard to these colors from a sanitary point of view, Austria has prohibited their use *in toto* in all articles of

food and drink. Other countries prohibit certain of the colors, which have been shown to be injurious, and allow all others to be used.

The experiments made upon the lower animals have, in the main, revealed negative results. Thus the writer about eight years ago fed some of the colors most commonly employed by confectioners to rabbits in order to test this question. One-half gram of the colors, among which magenta and corallin were included, was fed to as many rabbits per day for 10 days in succession without any apparent ill effects. The exhaustive treatise of Dr. Weil, translated by Leffmann, ascribes toxic effects to only a small number of the many colors employed by him in his experiments upon domestic animals.

The effect which these colors might exert upon digestive ferments, however, was a subject which had as yet received no attention, and the following experiments were undertaken in order to throw some light upon this question. The ferments employed were Armour's pepsin and pancreatine, liberal samples of which were kindly furnished by Armour & Co., of Chicago.

For the purpose of showing the digestive action, blood fibrin preserved in alcohol was employed. The fibrin was soaked and thoroughly washed with water to remove the alcohol, then pressed between filter paper, and the amount required for each experiment weighed off.

In each set of experiments a control experiment was carried on without the addition of color. The mixture was made as follows:

Hydrochloric acid solution (two-tenths per cent.)	100 cc.
Pepsin	20 milligrams.
Fibrin	1 gram.

This mixture placed in a large test tube was digested in a water bath at a temperature of 38° to 40° C. until the fibrin was dissolved.

At the same time similar mixtures as above, containing in addition 1, 0.5, 0.250, 0.125 and 0.062 gram of the color to be tested respectively, digested in the same water bath for the time required to dissolve the fibrin in the control experiment. Any fibrin remaining undissolved in the latter tests was removed, thoroughly washed, pressed between filter paper as before and weighed.

1. *Pepsin and Oroline Yellow.*—This color was one of a series employed in the coloring of confectionery, and was found to be what is known in the trade as *Acid Yellow* or *Fast Yellow*, and is a mixture of sodium amidoazobenzenedisulphonate with sodium amidoazobenzenemonosulphonate.

	Amount of Color. Gram.	Amount of Fibrin. Gram.	Amount of Pepsin. Gram.	Duration of Experiment. Hours.	Amount of Fibrin Dissolved. Gram.
1	0.0	1	0.020	3	1.0
2	1.0	1	0.020	3	0.1
3	0.5	1	0.020	3	0.12
4	0.25	1	0.020	3	0.22
5	0.125	1	0.020	3	0.35
6	0.062	1	0.020	3	0.73

From this it will be seen that even in test No. 6, where the color employed amounted to only one part in 1,600 parts of the solution, the presence of the color had still a depressing effect. For fear that, owing to the nature of this color, the hydrochloric acid might have been neutralized in part, the experiment was repeated with six-tenths per cent. solution of hydrochloric acid with similar results.

Of course, the determination of the fibrin dissolved is only approximate, as can readily be inferred from the way it was done.

In tests Nos. 2, 3 and 4 no change in the amount of fibrin was apparent to the eye. That a small part of the fibrin had gone into solution was confirmed by the fact that a slight precipitate of albuminoids was obtained on the addition of a solution of tannin. On the whole it must be conceded that this color has a marked and injurious effect upon peptic digestion.

2. *Pepsin and Soffoline.*—This is also a candy color and was found to be *acridine red.*

	Amount of Color. Gram,	Amount of Fibrin. Gram.	Amount of Pepsin. Gram.	Duration of Experiment. Hours.	Amount of Fibrin Dissolved. Gram.
1	0.0	1	0.020	3½	1
2	1.0	1	0 020	5	1
3	0.5	1	0.020	5	1
4	0.25	1	0.020	5	1
5	0.125	1	0.020	3½	1
6	0.062	1	0.020	3½	1

As will be seen from the table above, this color only slightly retards the digestion of the fibrin in the three stronger solutions, while in the last two tests there was no interference with the process. On the whole i may be said that the effect of this color on peptic digestion is practically nil.

3. *Pepsin and Magenta.*—It is needless to tabulate the results of this experiment. Suffice it to say that the solution of the fibrin in the five tests containing the same proportions of the color as employed above kept pace throughout the whole duration of the experiment with the control test, the fibrin in all cases dissolving at the expiration of 3½ hours.

This color, therefore, seems not to interfere with peptic digestion.

These four colors were also employed with pancreatin, and the method was as follows:

For the control experiment the following mixture was made:

Water	100 cc.
Sodium bicarbonate	1.5 grams.
Pancreatin	0.3 gram.
Fibrin	1.0 gram.

This mixture, contained in a large test tube, was digested in a water bath until the fibrin was peptonized. To test the effect of the colors, there was added to similar mixtures as above, 1, 0.5, 0.25, 0.125 and 0.062 gram of each color respectively.

5. *Pancreatin and Oroline Yellow.*—To the great surprise of the writer, this color, which had proved so effective in stopping and retarding peptic digestion, was found to exert no action whatever on the pancreatic ferment; the fibrin in all five of the tests with this color dissolved as freely as that of the control test. The solution of the fibrin in all cases was completed at the expiration of six hours.

6. *Pancreatin and Saffoline.*—The action of this color was quite different from that of oroline yellow, as the subjoined table will show.

	Amount of Color. Gram.	Amount of Fibrin. Gram.	Amount of Pancreatin. Gram.	Duration of Experiment. Hours.	Amount of Fibrin Dissolved. Gram.
1	0.0	1	0.3	6½	1.0
2	1.0	1	0.3	6½	0.0
3	0.5	1	0.3	6½	0.0
4	0.25	1	0.3	6½	0.55
5	0.125	1	0.3	6½	0.65
6	0.062	1	0.3	6½	0.75

These results show that in the two stronger solutions the action of the pancreatic ferment was entirely stopped, and that even in test No. 6, which contained only one part of color to 1,600 of the solution the action of the ferment was retarded to a marked extent.

Tannin precipitates the coloring matter.

7. *Pancreatine and Magenta.*—This color was as marked in retarding and stopping the action of pancreatine as saffoline. The results are given in the table below.

	Amount of Color. Gram.	Amount of Fibrin. Gram.	Amount of Pancreatine. Gram.	Duration of Experiment. Hour.	Amount of Fibrin Dissolved. Gram.
1	0.0	1	0.3	6½	1.0
2	1.0	1	0.3	6½	0.0
3	0.5	1	0.3	6½	0.0
4	0.25	1	0.3	6½	0.40
5	0.125	1	0.3	6½	0.60
6	0.062	1	0.3	6½	0.73

The solutions of tests 2 and 3 gave no precipitate with tannin. In all other tests the precipitate was either marked or heavy.

8. *Pancreatine and Methyl Orange.*—This color in all of the tests behaved like the last three colors described, completely stopping the action of the pancreatine in the two strongest solutions and retarding it to a marked extent in the weakest. The tabular statement would be similar to the last.

It seems, then, so far as these four colors are concerned, that none interfere with both peptic and pancreatic digestion, but that each color interferes seriously with either the one or the other. What the action of other coal tar colors may be, can, of course, not be inferred from this limited number of experiments, but it may safely be said that bodies which have such a decided action in retarding the most important functions of the animal economy cannot properly have a place in our daily food and drink.

Coal in Montana.

The *American Munufacturer* says that extensive coal fields are known to exist in the southern part of Montana, but until railroad facilities are increased it is impossible to operate them with any degree of profit. In the northern portion of the State, however, coal mines

are being worked very successfully and on a far more extensive scale than is generally supposed by those unfamiliar with the facts.

This is especially true of Cascade county, which now produces 70 per cent. of the total output of coal in the State. Yet experts report that the coal areas of this county are scarcely touched. Cascade county is particularly rich in minerals of this character, containing large deposits of coal, iron, gypsum, sandstone and limestone, many of these seeming to exist in unlimited quantities. The coal area of this county is estimated to be not less than 260 square miles, and the total output for 1895, while not definitely known, is supposed to be over 1,000,000 tons. More than 2,000 men are employed in the mines and various works connected with the industry. The most important coal fields of Cascade county consist of the four groups known as Sand Coulee, Belt, Otter Creek and Smith River, though other fields are constantly being opened, among which are Sun River and Dearborn fields.

The principal coal beds of Montana are those of Sand Coulee and Belt. Of these the mines at Belt are the oldest, having been worked in 1877 to supply the old military post at Fort Benton. At that time the annual output was only about 600 tons. Belt is now the largest coal town in the State, although its mines are not so extensive as the great coal mine of Sand Coulee.

Work was commenced in Sand Coulee about 1882, and until 1888 the output from this mine was 600 to 800 tons a year. But after the extension of the Great Northern Railway into Montana the production of this mine was increased in 1889 to over 150,000 tons, and from that time the amount has gradually increased each year, the output for 1894 being 500,000 tons. The capacity of this mine, when operated to its fullest extent, is 3,000 tons of coal in 10 hours. Estimating 20 tons of coal to a standard railroad car, 150 cars may readily be filled with coal every 10 hours. The mine is equipped with the latest machinery and all modern improvements. Cable cars are used to bring the coal to the surface, and there are six miles of subterranean car tracks. The cable line is operated so smoothly that the cars, each containing 100 tons of coal, make the round trip from the underground works to the surface and return in less than 30 minutes. By this method 300 tons of coal are brought to the surface and dumped into the coal cars every hour. Mining machines, worked by means of compressed air, are in operation throughout the mine.

Experts have estimated that the yield from the coal fields of Sand Coulee and Belt will be 600,000 tons to the square mile, and these are only two out of the many coal areas of the State. In the northern part of Cascade county is a field of lignite coal, which is being developed for the manufacture of briquettes.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Directors of the Newport (R. I.) Gas Light Company have ordered that the net gas rate in that city shall be $1.30 per 1,000 cubic feet, the concession to date from January 1st.

MR. HENRY H. ROGERS has been elected Vice-President of the Brookline (Mass.) Gas Light Company.

THE City Council of Norwalk, Ohio, has granted to Mr. Parks Foster, of Elyria, Ohio, a franchise for the operation in Norwalk of a fuel gas plant. As intimated in our issue for last week, Foster and his associates propose to use the pipes formerly employed in the supplying of natural gas to the residents of Norwalk by the Northwestern Natural Gas Company, which concern discontinued that supply some time ago.

THE authorities of the counties of Ocean and Monmouth, N. J., have just awarded the contract for a bridge, between Point Pleasant and Manasquan, to the Berlin Iron Bridge Company, of East Berlin, Conn. This bridge, which will be one of the longest highway bridges in the United States, is to have a length of 1,910 feet. The Secretary of War has ordered a draw span to be constructed in this bridge, the plans providing for two clear openings, of 45 feet and 50 feet, respectively. The Berlin Company's contract includes the substructure as well as the superstructure for the bridge.

MR. W. J. JONES, of Scranton, Pa., has been appointed Superintendent of the electric division of the Hackensack (N. J.) Gas Company's business, vice Mr. George T. Davison, resigned.

THE Pittsburgh (Pa.) *Times* says that the Pintsch gas plant in that city, which is located on Second avenue near Tenth street, will be completed by January 15th. The completion of that plant makes the forty-seventh station operated by the New York Safety Car Heating and Lighting Company between New York and the Pacific Coast. The *Times* further says that contracts have been made with the Baltimore and Ohio and the Pittsburgh and Lake Erie Railroads for equipping the passenger coaches so that compressed oil gas may be used for their illumination. This done, two 2-inch pipes will be laid across the Monongahela river, east of the Smithfield street bridge, opposite the Baltimore and Ohio passenger yards, so as to enter the passenger yards of the Pittsburgh and Lake Erie Road.

A CORRESPONDENT writes that the proprietors of the Rome (N. Y.) Gas and Electric Light Company have informed the residents that, beginning January 1st, the gross rate will be reduced to $2 per 1,000 cubic feet, with 5 per cent. off for prompt payment—the discount period extends to the 10th day from presentation of bills. Hitherto the rate was $3 per 1,000 cubic feet gross, with discounts of 20 cents, 50 cents, 75 cents, or $1 per 1,000, according to the quantity used each month; the maximum rebate applied to bills showing a monthly consumption of 5,000 cubic feet or over. "This move," says our correspondent, "goes to show that Superintendent Luther is of the progressive sort."

AT a recent meeting of the Medford (Mass.) Common Council, Mr. Gearish, as chairman of the Special Committee charged with the task of examining into the feasibility and advisability of establishing an electric lighting plant to be operated on municipal account, reported that the interests of the city would be better advanced by the building of a plant, in that such plant would not only be self-supporting, but that its operation would enhance the value of the city for residential purposes. It was deemed inexpedient to report the question for the people to consider at the last municipal election, but the Committee recommended that a similar Committee be appointed, with instructions to submit a report for the information of the voters, so that the question might be brought before the citizens at the next city election. The suggestions were adopted, and an order was passed providing that the former Special Committee be continued with instructions to proceed on the lines advocated.

AN explosion in the purifying plant of the Elyria (Ohio) Gas and Water Company resulted in severe personal injury to Ralph Barnes and his assistant, Albert Young. The building, although shaken up considerably, can be repaired at an expenditure of $200.

THE regular quarterly dividend of 2½ per cent. on the shares of the Cincinnati Gas Light and Coke Company is now payable.

AT the annual meeting of the shareholders of the Ilion and Mohawk (N. Y.) Gas Light Company the following officers were chosen: Directors, Thomas Ringwood, John Hoefler, A. E. Brooks, James Conklin, J. V. Schmidt, R. D. Le Roy, N. B. Alexander, A. N. Russell and M. J. Richards; President, Thomas Ringwood; Vice-President, John Hoefler; Treasurer, John V. Schmidt. The Company had a marked increase in business during the year, and about $13,000 was expended in plant betterment in the twelvemonth.

THE contract, for the piping of the new Court House at Moline, and the furnishing of the necessary gas fixtures as well, has been awarded to E. Baggot, of Chicago, at his bid of $1,700.

THE first meeting of the special committee of the Board of New York Aldermen, charged with the task of investigating the topic of the municipal ownership of gas works, and so on, was held on the afternoon of December 28th. According to the nature of the discussion, it is fair to assume that the committee will conduct a series of hearings next month, the purport of which will be to determine "the cost of making gas and the distribution thereof." Chairman Hall and Ald. Oakley were named a sub-committee to confer with the Mayor and the Corporation Counsel with a view to preparing a bill for submission to the legislature, empowering the committee to send for persons and papers, and to compel the attendance of witnesses to facilitate and render effective the work in hand. It was also decided to ask for an appropriation of $10,000 to defray the expenses of the committee.

MR. D. M. DUNNING, on behalf of the Auburn (N. Y.) Gas Light Company, in response to an invitation from the authorities to submit a figure at which it would agree to light the county buildings for the ensuing year, said the Company would furnish all the gas necessary for the lighting proposed at the rate of $1 per 1,000 cubic feet.

THE Finance Committee of Philadelphia City Council in considering the appropriation bills connected with the maintenance of the municipal gas works for the ensuing year, recommended the following allotments for the purposes named: Wages, $850,000; gas coal, $750,000; materials, supplies, etc., $300,000; for purchase of gas from the Philadelphia Gas Improvement Company, $750,000. The committee also recommended that the salary of the Assistant to the Chief and General Storekeeper be reduced to $1,500 from $3,000. The latter recommendation had its inception merely in politics of the infinitessimal sort, for the Gas Bureau has in its employ no more faithful and competent official than the incumbent of the place named—Mr. A. J. McCleary. The trouble, however, is that Mr. McCleary does not train with the particular political coterie to which Mr. Patton and others of the dominant power in Philadelphia gas circles declare their allegiance.

THE Amherst (Mass.) Gas Company is supplying electric current to incandescent electric lamps on an all-night schedule. The service was inaugurated on the 1st inst.

THE proprietors of the Charlestown (Mass.) Gas and Electric Company are arranging for a day service in that district of electric currents for light and power.

THE new catalogue of the Bristol's Company, which shows in plain way and describes in fair terms that which the Company has for sale, in the instance of "recording instruments for pressure, temperature and electricity," is worth writing for. The headquarters of the Company are in Waterbury, Conn.

WE have received from Mr. Irvin Butterworth, General Manager of the Columbus (Ohio) Gas Company, a handsome photograph of the interior of one of the largest shops in that city which is concerned in the sale of ready-made clothing. The picture reveals the lay-out of the main salesroom floor, and it also discloses the fact that the named room is brilliantly lighted by means of 200 Welsbach burners. The burners are arranged in the shape of a parallelogram, midway of the height of the room, and the effect is satisfactory in the extreme, both as to the quality of the illumination afforded and the cost at which it is obtained.

CERTAIN New York and Philadelphia capitalists, it is said, are about to submit a proposition to the authorities of Richmond, Va., looking to the purchasing or leasing of the Richmond municipal gas plant. This project likely had its inception in the recent discussion by the authorities under which it was proposed to increase the gas rate.

IT is reported that Messrs. H. Williams, B. C. Hawes, George Smith, Wm. J. Landers and Charles Dawburn have formed a Company to manufacture gas meters, with headquarters in San Leandro, Cal.

THE Welsbach burner is finding great favor with the storekeepers of Ware, Mass.

THERE is some chance that the owners of the charter (granted by the General Assembly of Connecticut in January, 1889) creating the Mystic Electric Light and Gas Company, to operate in the villages of Mystic River and Mystic Bridge, Conn., will construct a plant next spring. The named capital of the Company is $10,000, but the charter provides that it may at any time be increased to $50,000.

THE Easthampton (Mass.) Company reports a considerable increase in the number of meters set.

IN our issue for December 21st, 1896 (page 967) we described an apparatus, invented by Mr. George E. Woods, protected by U. S. Letters Patent No. 570,149, intended to act as a safety device in the operation of water gas producers. To complete that mention we should have said that Mr. Woods assigned all his right and title in the invention to Messrs. Humphreys & Glasgow, of this city.

A CORRESPONDENT at Little Rock, Ark., forwards the following: "An institution of which the citizens of Little Rock may well feel proud is the Pulaski Gas Light Company, which grew out of the reorganization of the Little Rock Gas Company in 1879. The Company's plant, which is thoroughly equipped with first class apparatus for the manufacture of a high quality of mixed coal and water gas, is situated at the foot of Cumberland street. The Company is strictly a home institution, for all of its stock is owned by citizens of Little Rock, and its affairs are managed by the following named gentlemen, who are prominent in local business circles and whose standing in the community is of the highest: President, Dr. C. M. Taylor; Treasurer, Mr. Oscar Davis; Manager, Mr. J. T. Pullen. Dr. Taylor has been at the head of the Company since January 1, 1896, and he gives considerable attention to its affairs. Since his election to the Presidency many improvements have been made on the plant. Of course, the brunt of the work devolves upon Mr. Pullen, the efficient Manager, who is a progressive young business man and who has had long schooling in the art of gas manufacturing. The rates charged are $2 per 1,000 cubic feet for an illuminating supply, and $1.50 per 1,000 for a fuel supply. The Company makes no charge for putting down services from its mains to the property line of the consumer."

THE *Gas World* says that an explosion of acetylene gas, resulting in the death of four persons, took place in a suburb of Berlin, Germany, on Saturday, December 12th. The immediate scene of the explosion was the laboratory of a chemist named Isaac, who for some time had been experimenting with the gas with a view of minimizing its dangerous qualities when under compression. It is said that he had made considerable progress in this direction, and that the Emperor himself had expressed a desire to visit the laboratory and see the result of the work. Herr Isaac was preparing on the day of the accident to receive a visit from Herr Thielin, head of the Imperial railways, who wished to examine the apparatus. He had hitherto experimented with only small quantities of the gas, but on this occasion he used a very large cylinder. This cylinder exploded, blowing the inventor and three workmen to pieces. Considerable damage was done to surrounding property. There is a grim humor in the regret of the newspapers that Herr Isaac's secret died with him.

THE following are the bids submitted by the named Companies in response to the invitation of the Gas Commission for proposals for the public lighting of New York for the next fiscal year:

Gas Company.	Candle Power.	Rate per Lamp.
Welsbach Street Lighting Co., single burners	60	$30.00
" " double burners	—	47.50
Consolidated Gas Co.	22	17.50
" " single Welsbach	—	30.00
" " double "	—	47.00
Standard Gas Light Co., 3 ft. burners	25	13.04½
" " 4-ft. "	25	15.50
" " 5-ft. "	25	18.00
Equitable Gas Light Co.	28	12.00
Northern Gas Light Co.[1]	20	28.00
Central Gas Light Co.,[2] 3-ft. burners	23	24.00
" " 5-ft. "	23	25.00
Yonkers Gas Light Company[3]	25	28.00

1. 24th Ward, except Kingsbridge. 2. 24th Ward only. 3. Kingsbridge only.

The bids submitted on electric lighting account were:

Company.	No. of Lights.	Rate per Night.
Brush	774	40 cents.
"	92	45 "
Mount Morris	519	40 "
North River	934	45 "
Edison Company, double lights, Fifth avenue	201	50 "
" single lights	259	40 "
Manhattan	760	40 "
"	10	50 "
Harlem	66	40 "
"	19	50 "

UNDER the reorganization of the artificial lighting interests connected with such supply in the towns of Dover, Somersworth, Rochester and Salmon Falls, N. H., the properties of the Consolidated Light and Power Company, of Dover, are to be taken over by the United Gas and Electric Company, which is capitalized in $250,000. The Manager of the Company will be Mr. H. L. Shepherd, of Rockport, Me.

The Roentgen Rays in Pharmacy.

Dr. Ferdinand Ranwez has made use of the X-rays to detect mineral substances added to saffron as adulterants, says the *Pharmaceutical Journal*. Out of four specimens so examined, only one was found to be pure; another contained 62.13 per cent. of the barium sulphate, and a third 11.75 per cent. of that compound, together with a certain proportion of potassium nitrate. The fourth specimen contained 50 per cent. of pure saffron, and the rest consisted of some substitute for that drug, faced with barium sulphate to the extent of 28.6 per cent. The plan adopted was to wrap a gelatino-bromide plate in black paper, place the saffron upon this on the same side as the sensitive film, then allow the rays to act for four minutes, afterward developing and fixing in the usual manner. The foreign matter is very sharply indicated in the print illustrating the paper, in the *Annales de Pharmacie* for May.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

The JOURNAL is the official organ of the
NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
AMERICAN GAS LIGHT ASSOCIATION.
WESTERN GAS ASSOCIATION.
OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.
TEXAS GAS AND ELECTRIC LIGHT ASSOCIATION.

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance.
Single copies, 10 Cents.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, JAN. 4, 1897.

The Market for Gas Securities.

The city gas share market ruled dull and lower for the week. Consolidated sold under 137, but rallied in the later trading. The opening to-day (Thursday) was 140½ to 141. Other city shares also show declines, especially Mutual, which is offered at 230, with 215 bid. The single exception, in fact, to the downward tendency is shown by Central, which advanced sharply to 175 bid. The following table will be of interest, as showing the changes for the year in the city shares named :

Company.	Dec. 30, '95.	Jan. 4, '97.
Consolidated	150–152	140½–141
Equitable	200–215	190 –195
Mutual	225–250	215 –230
Standard common	69– 75	81 – 85
N. Y. & E. R. "	35– 37	41 – 42½
Central	150– —	175 – —
Northern	79– 80½	85 – —

This list shows a queer condition of things, but it is nevertheless instructive. The outlook is rather uncertain, but the seeming belief of astute operators is that bottom figures have been reached. Meanwhile, our opinion is that the market is a good thing to keep out of. Brooklyn Union is quoted at 85 to 89. Chicago gas is steady. The opening in it to-day was 73 to 73½. Lacledes are dull and strong, as is Bay State. Columbus, Ohio, is reported at 68 to 70, and Detroit is weak and lower, at 19 to 25. Baltimore Consolidated is uneven and weaker, at 61 to 62, and Cincinnati is 199 bid, ex-div. of 2½ per cent.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

JAN. 4.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	140½	141
Central	500,000	50	175	205
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	190	195
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	215	230
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150,000	50	85	..
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	41	42½
Preferred	2,000,000	100	71	73
Bonds 1st 5's	3,500,000	1,000	105	106
" 1st Con. 5's	1,500,000	..	94	96
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	81	85
Preferred	5,000,000	100	106	109
Bonds, 1st Mortgage, 5's	1,500,000	1,000	109½	..
Yonkers	299,650	50	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	85	89
" " Bonds (5's)	15 000,000	1,000	105	105½
Bay State	5,000,000	50	11	11¼
" Income Bonds	2,000,000	1,000	..	85
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000		76
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	73	73½
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,000,000	..	68	70
1st Mortgage	1,085,000	..	..	96
Consumers. Jersey City	2,000,000	100	70	75
" Bonds	600,000	1,000	100	102
Cincinnati G. & C. Co.	7,000,000	100	199x	200
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	61	62
Mortgage, 6's	3,500,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	19	25
" Con. Bonds	4,312,000	..	..	82
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	82	86
" Bonds	2,000,000	..	85	90
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	128	133
" Bonds, 6's	2,650,000	..	103	105
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	84	88
Bonds	1,000,000	1,000	85	90
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	24½	24¾
Preferred	2,500,000	100	70	72
Bonds	9,034,400	1,000	93	..
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	98	98
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	90
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	97¾	98¼
St. Paul Gas Light Co.	1,500,000	100	67½	70
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	..	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	63	65
Bonds, 5's	3,556,000	.	90	93
Wilmington, Del.	500,000	50	180	182

Advertisers' Index.

GAS ENGINEERS.

	Page
Wm. Henry White, New York City	35
Fred. Bredel, Milwaukee, Wis.	21
Geo. R. Rowland, New York City	35
The Western Gas Construction Co., Fort Wayne, Ind.	26
Humphreys & Glasgow, New York City	22
T. G. Lansden, St. Louis, Mo.	35
American Gas Co., Phila., Pa.	17
David Leavitt Hough, New York City	37

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	33
United Gas Improvement Co., Phila., Pa.	25
Burdett Loomis, Hartford, Conn.	34
National Gas and Water Co., Chicago, Ills.	27
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	33
The Western Gas Construction Co., Fort Wayne, Ind.	26

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City	36
Continental Iron Works, Brooklyn, N. Y.	34
Delly & Fowler, Phila., Pa.	36
Kerr Murray Mfg. Co., Fort Wayne, Ind	22
Stacey Mfg. Co., Cincinnati, Ohio.	35
Bartlett, Hayward & Co., Baltimore, Md.	33
Davis and Farnum Mfg. Co., Waltham, Mass.	32
R. D. Wood & Co., Phila., Pa.	34
Isbell-Porter Company, New York City	34
Fred. Bredel, Milwaukee, Wis.	21
United Gas Improvement Co., Phila., Pa.	25
Berlin Iron Bridge Co., East Berlin, Conn.	22
National Gas and Water Co., Chicago, Ills.	27
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	33
The Western Gas Construction Co., Fort Wayne, Ind.	26
Humphreys & Glasgow, New York City	22
Gas Engineering Co., Pittsburgh, Pa.	32
American Gas Co., Phila., Pa.	17
Logan Iron Works, Brooklyn, N. Y.	16
Riter & Conley, Pittsburgh, Pa.	15

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City.	35
R. D. Wood & Co., Phila., Pa.	34
James R. Floyd & Sons, New York City	36
Continental Iron Works, Brooklyn, N. Y.	34
Gas Engineering Co., Pittsburgh, Pa.	32
Logan Iron Works, Brooklyn, N. Y.	16
Riter & Conley, Pittsburgh, Pa.	15

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md.	33
Fred. Bredel, Milwaukee, Wis.	21
J. H. Gautier & Co., Jersey City, N. J.	30
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.	20
Adam Weber New York City	30

TAR AND CARBONIC ACID EXTRACTOR.

G. Shepard Page's Sons, New York City.	35
R. D. Wood & Co., Phila., Pa.	34

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	15
G. Shepard Page's Sons, New York City	35
Gas Engineering Co,, Pittsburgh, Pa.	32

GAS METERS.

John J. Griffin & Co., Phila., Pa.	1044
American Meter Co., New York and Philadelphia.	30
The Goodwin Meter Co., Phila., Pa.	38
Helme & McIlhenny, Phila., Pa.	39
D. McDonald & Co., Albany, N.Y.	39
Nathaniel Tufts, Boston, Mass.	38
Maryland Meter and Mfg. Co., Baltimore, Md.	38
Metric Metal Co., Erie, Pa	38
Keystone Meter Co., Royersford, Pa.	16
Buhl Stamping Company, Detroit, Mich.	39

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia.	39
John J. Griffin & Co., Phila., Pa.	1044
D. McDonald & Co., Albany, N. Y.	39
Helme & McIlhenny, Phila., Pa.	39

GAS AND WATER PIPES.

Ohio Pipe Co., Columbus, Ohio	37
M. J. Drummond, New York City.	37
R. D. Wood & Co., Phila., Pa.	34
Warren Foundry and Machine Co., New York City.	37
Donaldson Iron Co., Emaus, Pa.	37
Addyston Pipe and Steel Co., Cincinnati, O.	37

PIPE CUTTERS.

Wm. Anderson, East Boston, Mass.	20

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City.	27

GAS COALS.

Penn Gas Coal Co., Phila., Pa.	21
Perkins & Co., New York City	28
Despard Gas Coal Co., Baltimore, Md.	29
Westmoreland Coal Co., Phila., Pa.	29
Berwind-White Coal Mining Co., New York and Phila.	28

CANNEL COALS.

Perkins & Co., New York City 28

GAS ENRICHERS.

Standard Oil Co., New York City 29
The Sun Oil Co., Fittsburgh, Pa..... 29

COKE CRUSHER.

C. M. Keller, Columbus, Ind..... 29

CONVEYING MACHINERY.

C. W. Hunt Company, N. Y. City 17

GAS GAUGES.

The Bristol Co., Waterbury, Conn..... 17

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City 27
Isbell-Porter Co., New York City..... 34
The Wilder Mfg. Co., Phila., Pa 16
R. D. Wood & Co., Phila., Pa..... 34

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Co., New York City..... 34
Continental Iron Works, Brooklyn, N.Y..... 34
G. Shepard Page's Sons, New York City..... 35
Logan Iron Works, Brooklyn, N. Y..... 16
R. D. Wood & Co., Phila., Pa. 34

CEMENTS.

C. L. Gerould & Co., Mount Vernon, N.Y..... 30

RETORTS AND FIREBRICKS.

J. H. Gautier & Co., Jersey City, N. J.. 30
B. Kreischer & Sons, New York City..... 30
Adam Weber, New York City..... 30
Laclede Firebrick Mfg. Co., St. Louis, Mo. 30
Cyrus Borgner, Phila., Pa..... 30
James Gardner, Jr., Pittsburgh, Pa..... 30
Henry Maurer & Son, New York City..... 30
Baltimore Retort and Firebrick Co., Baltimore, Md..... 30
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 30
Brooklyn Firebrick Works, Brooklyn, N. Y. 30
F. Behrend, New York City 29

INCANDESCENT GAS LAMPS.

Welsbach Commercial Co., Phila., Pa..... 19

MICA GOODS.

The Mica Mfg. Co., New York City..... 17

BURNERS.

C. A. Gefrorer, Phila., Pa..... 34
Theo. Clough, Dobbs Ferry, N. Y..... 15

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn..... 20

GAS TUBING.

Wm. M. Crane & Co., New York City..... 902

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 27
Greenpoint Chemical Works, Brooklyn, N.Y..... 27
Henry W. Douglas, Ann Arbor, Mich 27

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind 24
Isbell-Porter Company, New York City..... 34
Connelly Iron Sponge and Governor Co., New York City 27

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y. 26
Chapman Valve Manufacturing Co., Boston, Mass..... 26
R. D. Wood & Co., Phila., Pa..... 34
Continental Iron Works, Brooklyn, N. Y..... 34
The P. H. & F. M. Roots Co., Connersville, Ind..... 24
Isbell-Porter Co., New York City... 34
The Western Gas Construction Co., Fort Wayne, Ind.... 26

ELECTRICAL APPARATUS.

Wm. Henry White, New York City 35

GAS ENGINES.

Otto Gas Engine Works, Phila., Pa..... 40
The American Gas Engine Co., Phila., Pa 31
Backus Water Motor Co., Newark, N. J..... 15

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City..... 17
W. G. & G. Greenfield, East Newark, N. J..... 15

PURIFIER SCREENS.

John Cabot, New York City..... 20

GAS STOVES.

American Meter Co., New York and Philadelphia. 23
The Goodwin Meter Co., Phila., Pa..... 38
George M. Clark & Co., Chicago, Ills. 21
Maryland Meter and Manufacturing Co., Baltimore, Md. 38
William M. Crane & Co., New York City..... 902
Keystone Meter Co., Royersford, Pa..... 16
A. Weiskittel & Son, Baltimore, Md..... 20

CHINA GAS KILNS.

William M. Crane & Co., New York City..... 902

GASHOLDER PAINT.

New York Marine Paint Co., Poughkeepsie, N. Y..... 26

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y 26

ENGAGEMENT DESIRED.

An English Gas Engineer and Chemist, late teacher of gas manufacture, "City and Guilds of London Institute," author of numerous papers, thoroughly up to date in all departments of coal, oil and water gas, gas lighting, heating, working of residuals, etc., is open to accept appointment as Superintendent, Representative (to reliable firm) or Examiner. Highest references and testimonials as to ability, training, etc. Address, with particulars,

1122-5 "G. A.," care this Journal.

Position Desired

As Superintendent of Gas Works or Gas and Electric Light Works,

By a man 34 years of age. Sixteen years' experience in the manufacture and distribution of Coal Gas as Supt., and four years in the Electric line. Thoroughly competent to take charge of any plant, separately or combined. A practical mechanic, and understands the erection of gas plants and everything pertaining to the business. Not afraid of work. Salary no object until ability is proven. Best of references.

1102-tf Address "M. E. J.," care this Journal.

FOR SALE.

Hydraulic, Dip, Branch and Ascension Pipes, Mouthpieces and Lids, for four Benches of 5's and for one Bench of 3 retorts.

Two Coolers, or Air Condensers, each of 150 000 cubic feet capacity.

Multitubular Condenser, shell, 36 in. diameter, with 98 2-in. tube , 10 ft. 6 in. long.

D-Shaped Tar Extractor, 8 ft. long, 1 ft. 6 in. deep.

Scrubber, 48 in. diameter, 11 ft. 9 in. high. Three manholes, 11 in. by 15 in.

8-inch Center Seal. Four Purifiers, 8 ft. x 6 ft.

KEY CITY GAS CO.,
1119-tf Dubuque, Iowa.

For Sale.

A Small Gas and Electric Light Plant,

in a Southern city of 3,800 inhabitants.

Address FORT WAYNE ELECTRIC CORPORATION,
1097-tf Fort Wayne, Ind.

DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., DREXEL BUILDING, PHILA., Dec. 21, 1896.

The Directors have this day declared a quarterly dividend of 2 per cent. ($1 per share), payable on Jan. 15, 1897, to stockholders of record at the close of business Dec. 31, 1896. Checks will be mailed.

1125-3 EDWARD C. LEE, Treas.

Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator.

Not Expensive. Write to STROH & OSIUS, Pat'ees, or Mich. Ammonia Works, Detroit, Mich.

THEO. CLOUGH,

(Established 1870.)

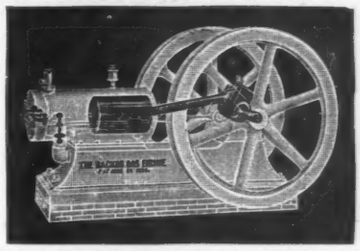
SOLE MANUFACTURER OF THE

Trade Mark **Maxim & Clough Adjustable Gas Burners** Trade Mark
Reg. Reg.

E. H Nickel Tips for Water Gas a Specialty.

THEO. CLOUGH, - - Dobbs Ferry, N. Y.

BACKUS GAS ENGINES

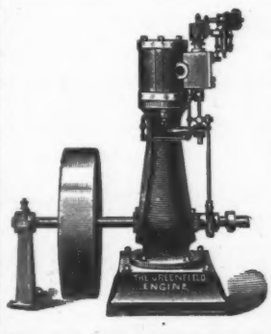


GUARANTEED SUPERIOR IN EVERY WAY. BUILT ON HONOR.

Agts. { Chicago Water Motor & Fan Co., 101 Lake St., Chicago. Michell & Co., - - 154 Congress Street, Boston, Mass.

Home Office, Backus Water Motor Co., Newark, N. J.

Send for Catalogue.



GREENFIELD Steam Engine Works.

Established 1874.

MANUFACTURERS OF

Greenfield Stationary, Portable and Yacht

ENGINES AND BOILERS.

Also Horizontal, Automatic and Variable Cut-off Engines.

Sizes from 3 to 75 Horse Power.

Also Vertical and Horizontal and Marine Boilers. Steam Pumps and Adams' Crate Bars.

W. G. & G. GREENFIELD, - · EAST NEWARK, N. J.

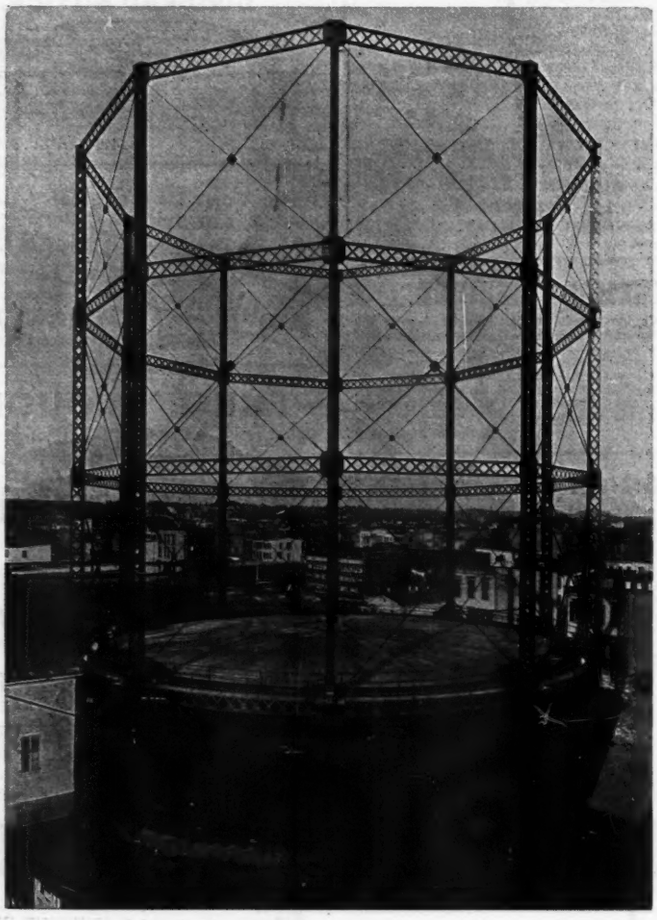
RITER & CONLEY, PITTSBURGH, PA.

GASHOLDERS, with or without Steel Tanks.

Purifiers, Condensers, Scrubbers, Oil Tanks, Smoke Stacks.

STEEL ROOFS and BUILDINGS.

PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.



The order for this Triple-Lift Holder and Steel Tank was received by the Logan Iron Works from the Union Gas Light Company, of East New York. The contract was completed and the Holder was in actual use in 90 days from receipt of order. Capacity of Holder, 500,000 Cu. Ft.

LOGAN IRON WORKS,

Brooklyn, N. Y.

MANUFACTURERS OF

Single or Multiple-Lift

GASHOLDERS,

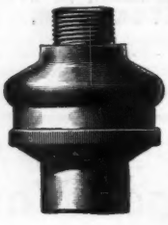
Complete with Steel Tanks.

BENCHES, SCRUBBERS,
CONDENSERS,
PURIFIERS, IRON ROOFS,
Self-Sealing Retort Lids,
AND ALL PARTS OF
GAS WORKS APPARATUS

Contractors for
Complete Works.

ALSO, SOLE MANUFACTURERS OF

C. W. BLODGET'S
HOT GAS SCRUBBER.



THE GREATEST IMPROVEMENT IN GAS LIGHTING
Has been made by
WILDER'S VOLUMETRIC GOVERNORS.

They control the pressure at the burner, and deliver the quantity for which they are set regardless of high or low pressure in the supply.

WELSBACH LIGHTS are fully controlled, and the governors soon pay for themselves by preventing the breaking of mantles and chimneys. Thousands are already in use. Orders may be given to the Welsbach Co., or sent to ourselves.

THE WILDER MANFG. CO., - - 818 Cherry St., PHILADELPHIA.

WIESTER & CO., 17 & 19 New Montgomery St., San Francisco, Cal.,

PACIFIC COAST AGENTS FOR **THE KEYSTONE METER CO.**

Gas Meters and All Apparatus for Measuring and Testing Gas.

REPAIRING, ALL KINDS OF METERS, PROMPTLY, AND SATISFACTION GUARANTEED

Other Agencies and Showrooms:

New York, New Jersey & Connecticut,
THE BARTLETT LAMP MFG. COMPANY,
66 W. Broadway, N. Y. City.

Western,
CAHILL, SWIFT & CO.,
121-207 S. 7th St., St. Louis, Mo.,

Main Office:
ROYERSFORD, PA.

••• A Full Stock ••• All Sizes on Hand ••• At these Points •••

The Pioneer Vertical Water-Tube Boiler of the World!

THE HAZELTON OR PORCUPINE BOILER.

After Sixteen Years of Active Service in all the Principal Industries, this Boiler has Proven Itself Superior to all Others in Economy of Fuel, Durability, Safety and General Efficiency.

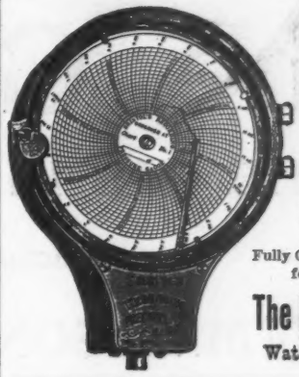
NO EXPLOSIONS OR ACCIDENTS OF ANY KIND.

Correspondence Solicited.

The HAZELTON BOILER COMPANY,

Sole Proprietors and Manufacturers,

Cable Address, "Palla," New York. Tele., "1229-18th St.," New York. Gen'l Office, 716 E. 13th St., N.Y., U.S.A.



BRISTOL'S RECORDING

PRESSURE GAUGE.

For continuous records of Street Gas Pressure

Simple in Construction, Accurate in Operation, Low in Price.

Fully Guaranteed. Send for Circulars.

The Bristol Co.,

Waterbury, Conn.

C. W. HUNT COMPANY.

COKE CARS for Gas Works,
TIP CARS for Carrying Ashes,
CHARGING CARS for Bringing Coal from the Storage Bins to Boiler Room and Retort Houses.

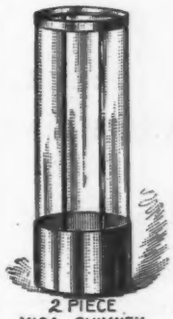
INDUSTRIAL RAILWAYS

Specially designed for handling material in and around

Gas Works, Coal Yards, Factories, Etc., Etc.

45 Broadway, N. Y. City.

Our Mica Chimneys



Etched Chimneys to Order.

For Welsbach Lights

ARE THE

BEST IN THE WORLD.

Get Catalog and Discounts.

The MICA MFG. CO

Micasmiths,

88 Fulton Street, N. Y. City.

AMERICAN GAS COMPANY,

222 South Third Street, Philadelphia, Pa.

Owns, Operates, Buys and Leases Gas Works.

ALSO UNDERTAKES ALL KINDS OF CONSTRUCTION WORK.

Especially the Installation or Extension of Plants for the Manufacture of Gas from Caking Coal.

The attention of Gas Managers is particularly called to the many improvements in this method of manufacture instituted during the past fifteen years, and the extremely low cost at present of Coal Gas.

CORRESPONDENCE RESPECTFULLY SOLICITED. Address

GEO. G. RAMSDELL, Gen'l Mangr.

The Gas Exposition.

THE GAS INDUSTRIES COMPANY, INCORPORATED.

Offices, 280 Broadway, New York City.

To be Held at MADISON SQUARE GARDEN, NEW YORK,

Beginning January 27 and Closing February 6, 1897.

OFFICERS:

President, PROF. CHARLES F. CHANDLER.

Vice Presidents, THOMAS F. ROWLAND, EMERSON McMILLIN, WALTER WOOD, THOMAS DOLAN, WM. R. BEAL
GEN. ANDREW HICKENLOOPER.

E. C. BROWN, Managing Director. L. J. MONTGOMERY, Secretary. GEORGE W. DOANE, Treasurer.

EXECUTIVE COMMITTEE:

E. C. BROWN, Chairman. EMERSON McMILLIN. COL. W. E. BARROWS. WM. H. BRADLEY. WALTON CLARK.

DIRECTORS:

Dr. Robert Amory, Boston.
Hon. Calvin S. Brice, New York.
Gov. Asa S. Bushnell, Columbus, O.
Wm. R. Beal, New York.
Col. W. E. Barrows, Gloucester, N. J.
Wm. H. Bradley, New York.
E. C. Brown, New York.
Prof. Charles F. Chandler, New York.
Walton Clark, Philadelphia.

Thomas Dolan, Philadelphia.
G. W. Doane, New York.
A. B. Eilbeck, Philadelphia.
H. E. Gawtry, New York.
E. P. Gleason, New York.
T. J. Hayward, Baltimore.
Prof. William Hallock, New York.
Alexander C. Humphreys, New York.
Gen. Andrew Hickenlooper, Cincinnati.

Charles E. Judson, Chicago.
Gen. James Jourdan, Brooklyn.
John Kean, Elizabeth, N. J.
Emerson McMillin, New York.
Edm'd H. McCullough, Philadelphia.
Dr. Henry Morton, Hoboken, N. J.
Prof. T. C. Mendenhall, Worcester, Mass.
Martin Maloney, Philadelphia.
Wm. J. Murphy, Minneapolis.

Albion L. Page, New York.
Thomas F. Rowland, New York.
Frank Tilford, New York.
Prof. R. H. Thurston, Ithaca N. Y.
Eugene Vanderpool, Newark, N. J.
Capt. Wm. H. White, New York.
Dr. Wm. H. Wahl, Philadelphia.
Walter Wood, Philadelphia.

The Gas Associations have Appointed the Following Representatives:

W. M. EATON, Michigan Gas Asso. J. A. BRITTON, Pacific Coast Gas Asso. IRVIN BUTTERWORTH, Ohio Gas Light Asso. GEO. T. THOMPSON, Western Gas Asso.

C. J. R. HUMPHREYS, American Gas Lt. Asso. C. H. NETTLETON, New England Asso. of Gas Engineers.

Every indication points to the attendance of gas men from near by as well as from the most remote sections of the country. Arrangements are now under way for providing hotel and railway facilities for members of the gas fraternity who may wish to visit New York during the Exposition.

Several New York hotels have offered special rates.

Full particulars on these points will be given very shortly.

The Historical Exhibit will embrace many articles of surpassing interest. A celebrated collection of ancient lamps and lighting appliances, consisting of several hundred rare specimens never exhibited outside the great institution in which the collection is now lodged, is promised.

GAS MEN'S NIGHT.

The Ohio Gas Light Association will hold its annual meeting in this city during the Gas Exposition. Date, February 3 and 4. The management has designated Wednesday evening, February 3, as **Gas Men's Night.** A programme will be made up covering this feature that will appeal to all as befitting the occasion.

THE TIFFANY GAS TOWER,

With its Myriad of Lights and Beautiful Decorative Effects. Worth a Thousand Mile Journey to See.

INJUNCTION ISSUED AGAINST INFRINGERS.

On September 23d the United States Circuit Court for the Southern District of New York granted an injunction restraining and enjoining the further infringement of our Welsbach patent. READ IT.

UNITED STATES CIRCUIT COURT,
Southern District of New York.

WELSBACH LIGHT COMPANY,
vs.
A. LIEBES. } IN EQUITY.

The President of the United States,

To A. LIEBES, and his servants, agents, attorneys and workmen, GREETING:

WHEREAS, It has been represented to us in our Circuit Court of the United States for the Second Circuit and Southern District of New York, that Letters Patent of the United States No. 438,125, were issued in due form of law on the 7th day of October, 1890, to Carl Auer von Welsbach, assignor of the complainant, then known as "Welsbach Incandescent Gas Light Company of New Jersey," and that the complainant herein is the owner of said Letters Patent, and that you, the said A. Liebes, have infringed the rights secured by the aforesaid Letters Patent, by making, using and selling to others to be used, incandescent devices for gas burners, embodying and containing the invention and improvements described and claimed in said Letters Patent No 438,125.

NOW, THEREFORE, We do strictly command and enjoin you, the said A. Liebes, and your attorneys, agents, servants and workmen under the penalties which may fall upon you in case of disobedience, that you forthwith and forever desist from directly or indirectly making, or causing to be made, delivering, vending, or causing to be sold, offering for sale, using, or causing to be used in any manner, any incandescent devices for gas burners, like, or similar to those which you have heretofore made, used or sold, containing or embodying the invention and improvements described in said Letters Patent No. 438,125, and claimed in the claim thereof, and from counterfeiting or imitating the said invention or improvements or any part or parts thereof, and from in any manner or way whatsoever, violating or infringing the said Letters Patent No. 438,125 and the claim thereof, and from doing, or causing to be done, any other act or thing whatsoever in infringement of the said Letters Patent No. 438,125.

WITNESS, The Honorable Melville W. Fuller, Chief Justice of the United States, at the City of New York, in the Southern District of New York, this twenty-fourth day of September, A. D., 1896.

(SEAL.) JOHN A. SHIELDS, Clerk.

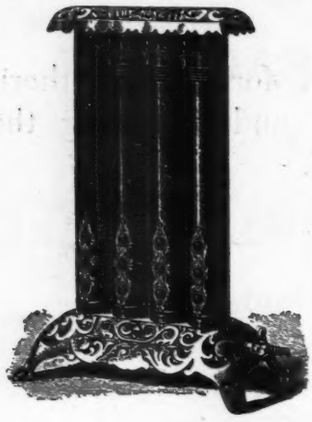
(Endorsed) U. S. Circuit Court, Southern District of New York, in Equity.—Welsbach Light Company vs. A. Liebes. Injunction.

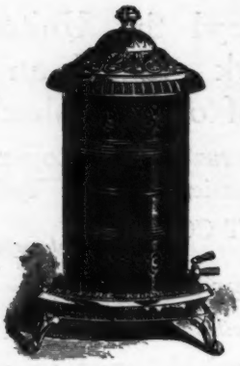
A Copy of a Writ of Injunction this day issued out of my office. JOHN A. SHIELDS, Clerk.

We shall proceed against all infringers; manufacturers, dealers and users being equally liable to injunction and damages. The decree of the court awarding the injunction also awards profits and damages. Do not be misled or deceived by guarantees offered by infringers, as such guarantees will not protect you against suit, injunction and damages. For your own protection see that you get the genuine Welsbach light. All other incandescent gas lights are infringements.

WELSBACH LIGHT COMPANY.

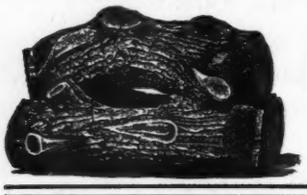
FIRE KING GAS HEATERS.





Best in the World.

Best Constructed, Finest Finished and Most Economical Gas Stoves Made. Send for Beautiful New Catalogue, just issued, and get our Prices before buying.



MANUFACTURED BY

A. WEISKITTEL & SON, Baltimore, Md.

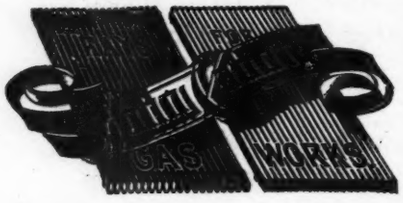
New York Branch, 1387 Broadway.

New England Agents, WALDO BROS., Boston.

Special Trays for Iron Sponge or Oxide of Iron,

CHURCH'S TRAYS a Specialty.

Reversible, Strongest, Most Durable, Most Easily Repaired.



306-310 Eleventh Avenue, New York.

We also make the Cheapest and Strongest REVERSIBLE BOLTED TRAYS IN THE MARKET.

Send for Circulars.

THE ANDERSON Patent Cutter Carrying Link
Made in all sizes.

Will cut from 2 in. to 24 in.

Pipe Cutting Tool

For Cutting Cast, Wrought Iron, Gas & Water Pipes.

WM. ANDERSON,
425 Meridian Street, East Boston, Mass., or
WALDO BROS.,
88 Water Street, Boston, Mass.

F. BEHREND,

SOLE IMPORTER OF THE CELEBRATED

German (Stettin-Didier) Clay Gas Retorts,

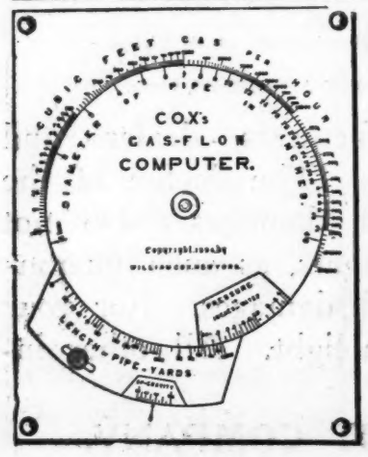
BLOCKS, TILES, FIREBRICKS, FIRE CEMENT,
Stettin "Anchor" & "Eagle" Brand Portland Cement

10 & 12 Old Slip, New York.

Patent Lava Gas Tips.

UNIFORMITY GUARANTEED.
ALL SIZES AND SHAPES.

D. M. STEWARD MFG. CO.,
CHATTANOOGA, TENN.



Cox's Gas Flow Computer.

1. It gives at a glance the discharge of gas from pipes 1 to 48 inches in diameter and 10 to 10,000 yds. long, for any pressure from 0.01 to 10.0 inches of water, and any specific gravity from 0.40 to 1.00.
2. When the required discharge and the length of pipe are given, the diameter corresponding to any pressure is at once seen.
3. When the required discharge and the length of pipe are given, the pressure corresponding to any diameter is at once found.
4. Any suitable combination of the different factors of any problem, under all possible conditions, may be immediately found.

It Prevents Errors and Saves Hours of Tiresome Calculations.

Price, $5.00, per Registered Mail.

For sale by

A. M. CALLENDER & CO., 32 Pine St., N. Y. City.

Jewel Gas Stoves

For 1897

WILL BE THE TALK OF THE TRADE!

New Stoves, with New Features.
Nothing Like Them. . . . . .

The buyer who considers Quality first, and makes Price a secondary consideration, is the successful one, because he pleases his trade and thereby increases his business. **JEWELS** are leaders in Mechanical Perfection. Our Catalog will be ready about February 1st. Send for a copy **now** and we'll have you on the list.

GEORGE M. CLARK & COMPANY, 161 Superior St., Chicago.

When writing, mention this Paper.

FRED. BREDEL, C.E.

Coal and Water Gas Plants,

OWN SYSTEM.

Recuperative Furnaces, Washers, Condensers, Purifiers, Purifying Machines.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

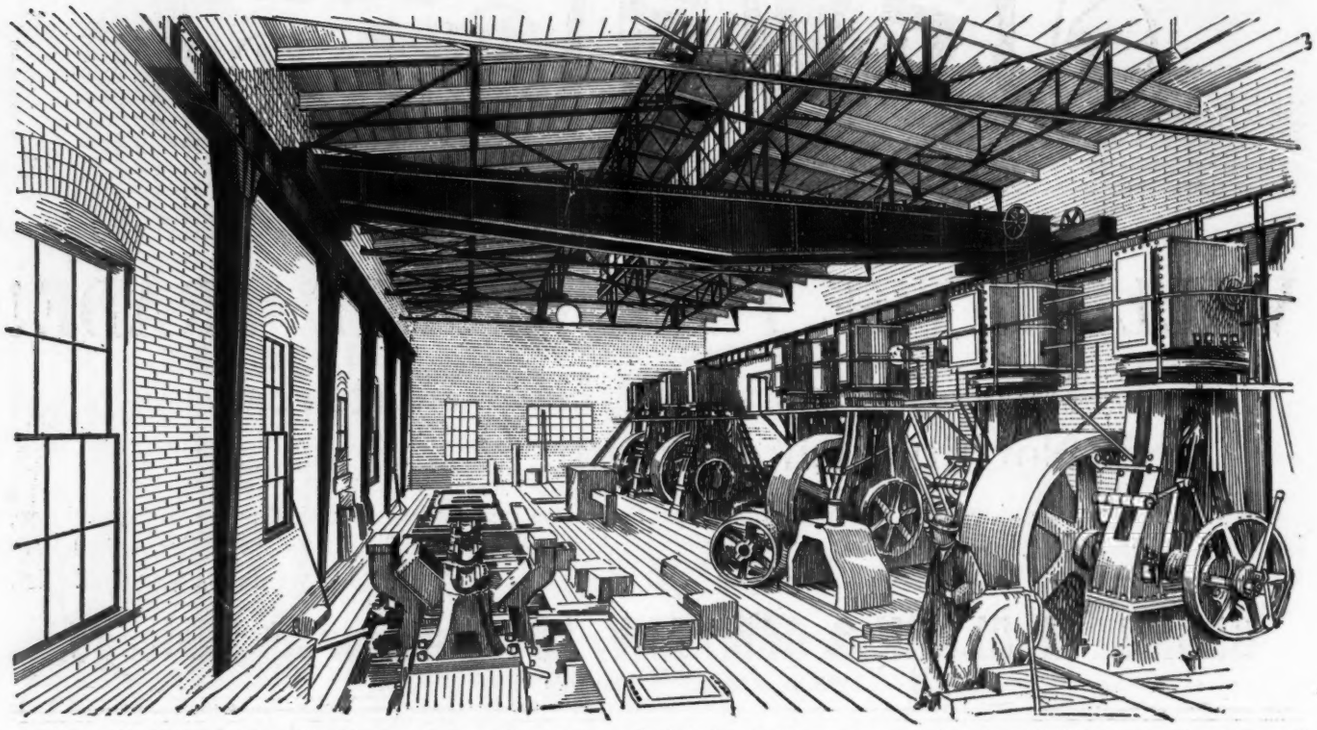
COMPLETE GAS WORKS, COKE CONVEYERS, ETC.

No. 118 Farwell Avenue, · · Milwaukee, Wis.

CHAS. M. JARVIS, Prest. & Chief Engineer. BURR K. FIELD, Vice-President. GEO. H. SAGE, Secretary. FRANK L. WILCOX, Treasurer.

THE BERLIN IRON BRIDGE CO.

Engineers, Architects, and Builders of Iron and Steel Structures.



The above illustration is taken direct from a photograph, and shows the interior of a Power House designed and built by us for the Worcester Traction Company, at Worcester, Mass. The building is 47 feet wide and 120 feet long, with a traveling crane as shown. The roof being very flat, it is covered with plank and tar and gravel. The entire frame work is of steel, a light brick wall being placed between the posts to protect the interior of the building from the weather.

Write for Illustrated Catalogue.

Office and Works, No. 6 Railroad Avenue, East Berlin, Conn.

ALEX. C. HUMPHREYS, M.E., MANHATTAN LIFE BUILDING, (64 BROADWAY,) NEW YORK.

CABLE ADDRESS, LONDON & NEW YORK, "HUMGLAS."

ARTHUR G. GLASGOW, M.E., 9 VICTORIA ST., LONDON, S. W., ENGLAND.

HUMPHREYS & GLASGOW,

CONTRACTING AND CONSULTING

GAS ENGINEERS.

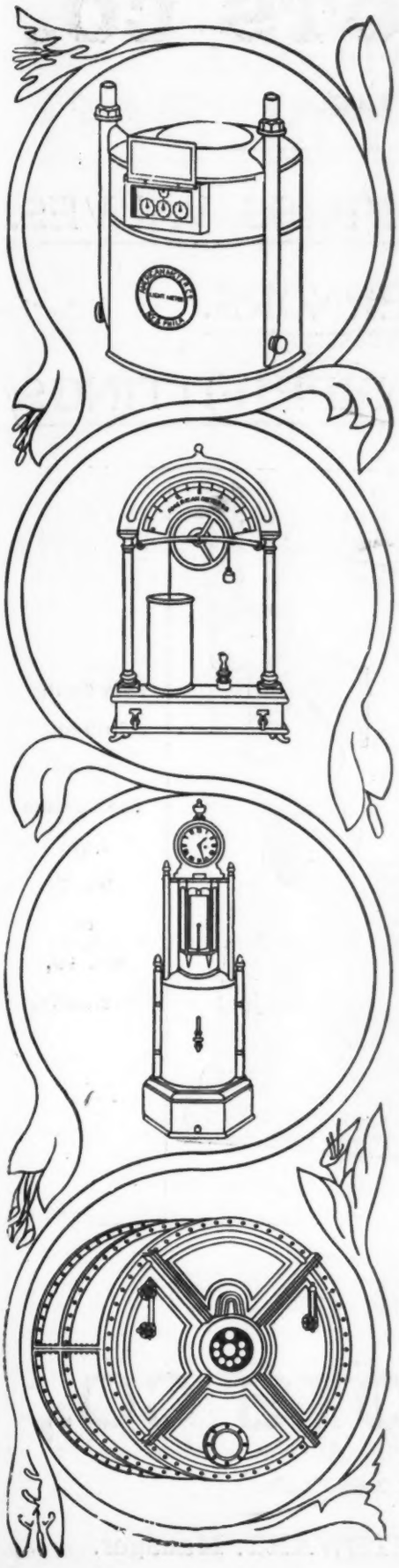
WATER GAS PLANT A SPECIALTY.
GAS PROPERTIES EXAMINED AND VALUED.
ADVICE AS TO IMPROVEMENT OF GAS PROPERTIES AND MANAGEMENT.

THE MANAGEMENT OF SMALL GAS WORKS.

By C. J. R. HUMPHREYS.

Price $1.

A. M. CALLENDER & CO., No. 32 Pine Street New York.



(Copyrighted, 1894, by the AMERICAN METER CO.

AMERICAN METER CO.

ESTABLISHED 1834. INCORPORATED 1863.

NEW YORK AND PHILADELPHIA,
CHICAGO, ST. LOUIS,
SAN FRANCISCO.

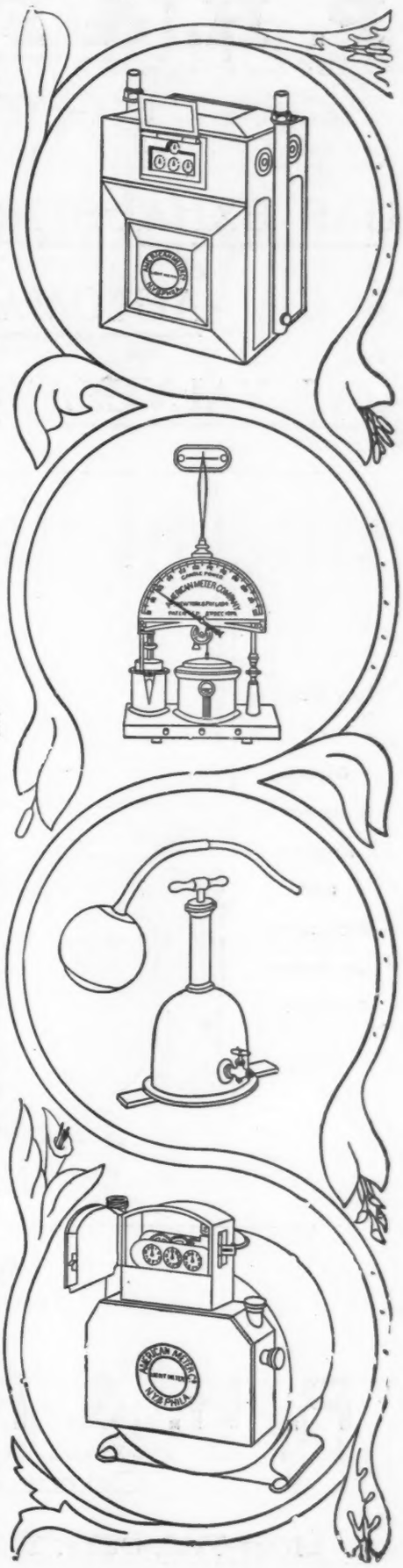
PUBLIC LIGHTING TABLE.

JANUARY, 1897.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Fri.	1	5.10 PM	6.20 AM	4.30	6.30
Sat.	2	5.10 NM	6.20	4.30	6.30
Sun.	3	5.20	6.20	4.30	6.30
Mon.	4	5.20	6.20	4.30	6.30
Tue.	5	5.20	6.20	4.30	6.30
Wed.	6	5.20	6.20	4.30	6.30
Thu.	7	8.50	6.20	4.30	6.30
Fri.	8	9.50	6.20	4.40	6.30
Sat.	9	10.50	6.20	4.40	6.30
Sun.	10	11.50 FQ	6.20	4.40	6.30
Mon.	11	12.50 AM	6.20	4.40	6.30
Tue.	12	1.50	6.20	4.40	6.30
Wed.	13	2.50	6.20	4.40	6.30
Thu.	14	3.50	6.20	4.40	6.30
Fri.	15	4.50	6.20	4.50	6.25
Sat.	16	5.40	6.20	4.50	6.25
Sun.	17	No L.	No L.	4.50	6.25
Mon.	18	No L. FM	No L.	4.50	6.25
Tue.	19	No L.	No L.	4.50	6.25
Wed.	20	5.40 PM	8.20 PM	4.50	6.25
Thu.	21	5.40	9.30	4.50	6.25
Fri.	22	5.40	10.40	5.00	6.25
Sat.	23	5.40	11.50	5.00	6.25
Sun.	24	5.40	1.10 AM	5.00	6.25
Mon.	25	5.40 LQ	2.20	5.00	6.25
Tue.	26	5.40	3.40	5.00	6.25
Wed.	27	5.40	4.50	5.00	6.25
Thu.	28	5.40	5.50	5.00	6.25
Fri.	29	5.40	6.10	5.05	6.15
Sat.	30	5.40	6.10	5.05	6.15
Sun.	31	5.50	6.10	5.05	6.15

TOTAL HOURS LIGHTING DURING 1897.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	233.00	January	423.20
February	187.20	February	355.25
March	202.00	March	355.35
April	170.40	April	298.50
May	163.00	May	264.50
June	140.40	June	234.25
July	151.40	July	243.45
August	167.30	August	280.25
September	174.40	September	321.15
October	200.00	October	374.30
November	205.20	November	401.40
December	220.10	December	433.45
Total, yr.	2216.00	Total, yr.	3987.45



P. H. & F. M. ROOTS CO.,

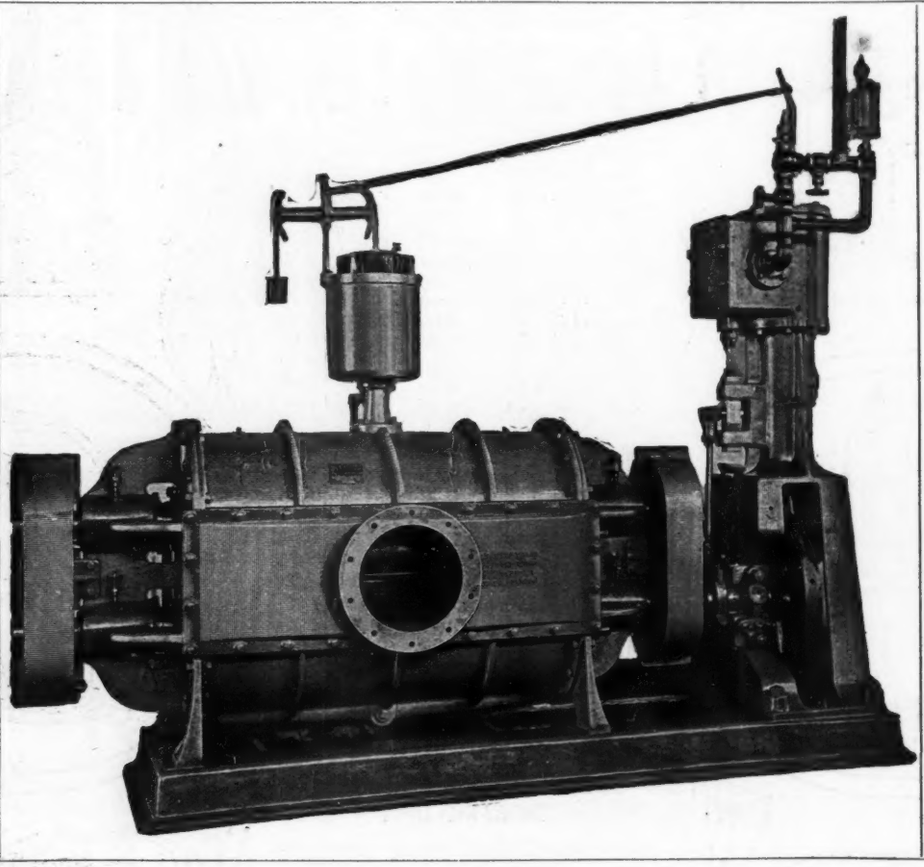
Connersville, Ind.

GAS EXHAUSTERS. BYE-PASS VALVES.

AUTOMATIC GAS GOVERNORS.

GAS VALVES. PIPE FITTINGS.

New Design of Direct Connected Engine and Exhauster on Same Bedplate.



This Design is Used for all Exhausters from No. 7 to No. 10, Inclusive.

Write for Illustrated Catalogue.
Estimates submitted on application.

P. H. & F. M. ROOTS CO.,

Connersville, Indiana.

New York Office, 109 Liberty Street, J. B. STEWART. Manager.

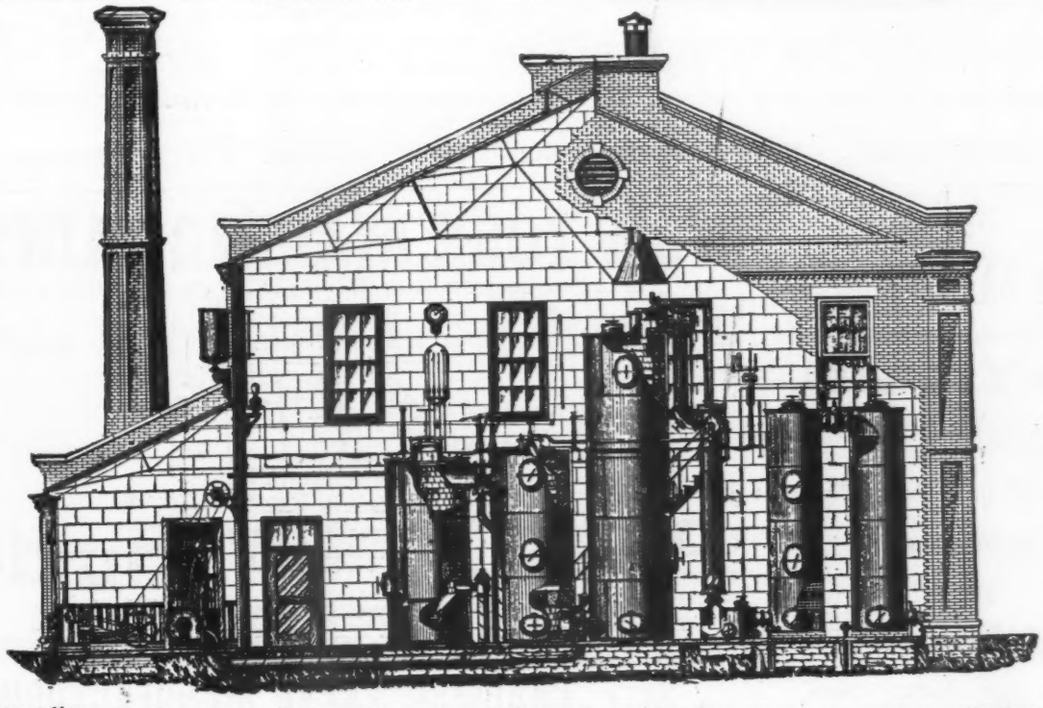
THE UNITED GAS IMPROVEMENT CO.,

DREXEL BUILDING, PHILA., PA.

Inquiries from any part of the United States should be addressed to the Philadelphia Office.

BUILDERS OF

THE STANDARD LOWE WATER GAS APPARATUS.



Standard "Double Superheater" Lowe Apparatus, designed for the use of Naphtha, Crude Oil, or "Distillates."

BUILDERS, LESSEES AND PURCHASERS OF GAS WORKS.

Water Gas Plants, either independent or auxiliary to Coal Gas Works, erected to meet any conditions. Apparatus designed to use any grade of Oil, and Anthracite Coal, or Gas House or Oven Coke.

PAMPHLETS, PLANS AND ESTIMATES FURNISHED UPON APPLICATION.

THE WESTERN GAS CONSTRUCTION CO.,

ENGINEERS and BUILDERS,

FORT WAYNE, INDIANA.

Water Gas Apparatus . . .

Improved Double Superheater Settings,
Improved Single Superheater Settings,
Special Designs for Small Works.

Our apparatus is designed to use any grades of Oils or Naphthas, Gas House or Oven Coke, or Anthracite Coal. Results are Guaranteed.

Coal Gas Apparatus . . .

Agents and Builders. { For FRED. BREDEL—Washers and Purifying System, Mouthpieces and Bench Castings,
For GEO. SHEPARD PAGE'S SONS—Walker Ammonia Concentrators and Sulphate Stills,
Walker Patent Mouthpieces.

Manufacturers of THE WESTERN GAS VALVE, all Iron, Double Gate, 4 to 36 Inch.

Purifiers, Condensers, Scrubbers, Street Main Specials, Iron Roofs, Iron Floors, Oxide Elevators and Conveyer Machinery.

NEW YORK OFFICE, 32 Pine Street, WM. HENRY WHITE, Engr.

THE
LUDLOW VALVE MFG. CO.,
MANUFACTURERS OF
VALVES,

Double and Single Gate, ¾ in. to 72 in., outside and inside Screws. Indicator, etc., for Gas, Water, Steam, Oil and Ammonia.

SEND FOR CIRCULAR.

SEND FOR CIRCULAR.

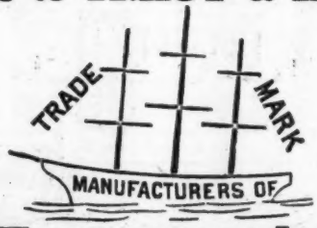
ALSO,

Hydraulic Main Dip Regulators, Check Valves, Foot Valves, Yard Wash and Fire Hydrants.

OFFICE AND WORKS:
938 to 954 River St., & 67 to 83 Vail Av.
TROY, N. Y.

NEW YORK MARINE PAINT CO.

Successors to TRACY & HADDEN.



PAINT PECULIARLY ADAPTED TO STAND ON Holders

And all Ironwork about Gas Works.

POUGHKEEPSIE, N. Y.

CHAPMAN VALVE MANUFACTURING CO.,

MANUFACTURERS OF

Valves and Gates for Gas, Ammonia, Water, Etc.

Also, Gate Fire Hydrants with and without Independent Nozzle Valve. All Work Guaranteed.

Works & Gen'l Office, Indian Orchard, Mass. Treasurer's Office, 72 Kilby & 112 Milk Sts., Boston, Mass.
Chicago Office, 24 West Lake St. New York Office, 28 Platt St.
St. Louis Office, L. M. Rumsey Mfg. Co., 810 North Second St.

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE

Plans prepared and Estimates furnished at short notice.

J. P. WHITTIER,

70 Rush St., Near Division Ave., **Brooklyn, N. Y.**

The Gas Engineer's Laboratory Handbook.

By JOHN HORNBY, F.I.C.

Price, $2.50.

A. M. CALLENDER & CO., 32 Pine Street, N.Y. City

NATIONAL GAS AND WATER CO.,

218 La Salle Street, Chicago.

Builder and Operator of Gas Works.

The Rew Soft Coal Carbureted Water Gas Apparatus.

TESTED BY THREE YEARS' PRACTICAL OPERATION, AND FULLY GUARANTEED.

Plans and Estimates Upon Application.

IRWIN REW, President and Treasurer. E. E. MORRELL, Engineer.

CONNELLY IRON SPONGE AND GOVERNOR CO.,

(Successors to CONNELLY & CO.)

MANUFACTURERS OF GAS WORKS SPECIALTIES.

"IRON SPONGE." Saves money, saves labor, and is the most efficient purifying material ever offered as a substitute for lime. We guarantee a large saving, both in cost of material and labor.

AUTOMATIC GOVERNOR. OVER FOUR HUNDRED NOW IN USE! NO WORKS COMPLETE WITHOUT IT! WILL PAY FOR ITSELF WITHIN A YEAR! ITS SERVICE SECURES PERFECT DISTRIBUTION! REDUCES LEAKAGE TO MINIMUM, and BENEFITS THE COMPANY and CONSUMER ALIKE! IT IS THE ONLY RECOGNIZED AUTOMATIC GOVERNOR IN THE WORLD!

STEAM JET EXHAUSTER. Designed particularly for small works. Combines Exhaust Tube, Steam Governor, Gas Compensator and Bye-Pass Valves in the most compact form possible. Occupies but little space; uses very little steam; saves formation of carbon in retorts; increases yield 10 to 15 per cent. No works too small to use them profitably.

Prices given on all our specialties, delivered at any point in the United States. Correspondence solicited.

CONNELLY IRON SPONGE AND GOVERNOR CO., No. 365 Canal St., New York.

The Theory of Success.

The New York Central managemement evidently proceeds on the theory that the more care there is taken of a traveler, the more he will travel—witness its "Limited" trains, block signals, free attendants and the comfort and luxury surrounding one from beginning to end of a journey on "America's Greatest Railroad."

DOUGLAS' FERRIC OXIDE

For Gas Purification

Is a superior natural Hydrated Oxide of Iron. Will give a higher purification per bushel than any other material. We ship the pure Oxide of Iron, containing no sawdust, thus effecting a saving in freight, leaving the consumer to furnish the diluent at a nominal cost. It is now used by the largest gas companies in the West.

Full information, with references to many users, and prices delivered in any locality, furnished on application to

H. W. Douglas (Supt. Ann Arbor Gas Company) **Ann Arbor, Mich.**

IRON MASS

For Gas Purification.

Acts immediately, and more efficiently than any other purifying agent now in use.

Greenpoint Chemical Works.

JOHN SCHRIEVER, Manager.

Greenpoint Ave. & Newtown Creek, Brooklyn N.Y

BOOKS.

DISTILLATION OF COAL TAR AN AMMONIACAL LIQUOR.

By George Lunge. Price $12.50.

TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS.

By David A. Graham. 8vo., Cloth. Price $3.

Orders for these books may be sent to this office.

A. M. CALLENDER & CO., Pine St., N. Y. City

Parson's Steam Blower,

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER.

FOR UTILIZING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER.

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY

H. E. PARSON, Supt., 621 Broadway N. Y.

JAMES D. PERKINS. **PERKINS & CO.,** F. SEAVERNS.

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

Ocean Mine Youghiogheny Gas Coal,

Clinch Valley, Thacker & Logan Gas Coals

Old Kentucky Shale and O. K. Boghead.

Shipments from New York, Philadelphia, Baltimore and Norfolk.

BERWIND-WHITE COAL MINING COMPANY'S

Ocean Westmoreland Gas Coal.

Offices:
Washington Building, New York.
Betz Building, Philadelphia.

STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
Heavy Steaming.

FIELD'S ANALYSIS

For the Year 1895.

An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland, and Ireland. Being the Twenty-seventh Year of Publication. Compiled and Arranged by

JOHN W. FIELD, Sec. & Gen. Mangr. of The Gas Lt. & Coke Co., London.

Price, $5. For Sale by

A. M. CALLENDER & CO., - No. 32 Pine Street, N. Y. City.

Coal Tar Genealogical Tree

MR. T. VINER CLARKE, of London, Eng., having compiled a novel Chart or Map illustrating the various

CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR,

In the form of a Genealogical Tree, including all the products discovered to date (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

GAS ENRICHERS. GAS COALS. GAS COALS.

The Despard Gas Coal Co.,

MINERS AND SHIPPERS OF

DESPARD GAS COAL,

AND MANUFACTURERS OF

COKE.

MINES, - - Clarksburgh, Harrison Co., West Va.
WHARVES, - - - Locust Point, Baltimore, Md.
OFFICE, - - - 44 South Street, Baltimore, Md.

ROUSSEL & HICKS, 71 Broadway, N. Y. } AGENTS, { BANGS & HORTON, 60 Congress St., Boston.

KELLER ADJUSTABLE COKE CRUSHER.

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER,
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

The EMPIRE STATE EXPRESS of THE NEW YORK CENTRAL is the Fastest and Most Famous Train in the World . . . . . .

GREENOUGH'S

"DIGEST OF GAS CASES."

Price, $5.00.

This is a valuable and important work, a copy of which should be in the possession of every gas company in the country, whether large or small. As a book of reference it will be found invaluable. It is the only work of the kind which has ever been published in this country, and is most complete. Handsomely bound. Orders may be sent to

A. M. CALLENDER & CO., 39 Pine St., N. Y.

— THE —

PENN GAS COAL CO.

OFFER THEIR

Coal, Carefully Screened and Prepared for Gas Purposes.

Their property is located in the Youghiogheny Coal Basin, near Irwin and Penn Stations on the Pennsylvania Railroad, and on the Youghiogheny River.

Principal Office:

Room 720, Reading Terminal Building, Phila., Pa.

Points of Shipment:

Pennsylvania Railroad Piers; Greenwich Wharves, Delaware River; Pier No. 1 (Lower Side), South Amboy, N. J.

EDMUND H. McCULLOUGH, Prest. CHAS. F. GODSHALL, Treas. H. C. ADAMS, Sec.

THE WESTMORELAND COAL CO.

Chartered 1854.

Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas giving qualities, and in freedom from sulphur and other impurities.

Principal Office, 224 South 3d St., Phila., Pa.

THE SUN OIL CO.,

OHIO CRUDE OIL,

38 to 41 Degrees Gravity.

Toledo, O., and Pittsburgh, Pa.

Standard Oil Company,

GAS NAPTHA DEPARTMENT.

GAS NAPTHA.

GAS OIL.

Correspondence Solicited.

26 Broadway, New York City

RETORTS AND FIRE BRICK. RETORTS AND FIRE BRICK. RETORTS AND FIRE BRICK.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF
CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE
FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,

MANUFACTURERS OF
CLAY RETORTS, FIRE BRICK,
Gas House and other Tile.
Office, 88 Van Dyke St., Brooklyn, N. Y.

Established 1854. Incorporated 1869.

LACLEDE
Fire Brick Manufg. Co.,

Manufacturers of { GAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Exclusive Agents for
The Mitchell Half-Depth Regenerative Furnace.

This is the *original* coal-consuming Furnace for Retort Benches. Burns either Coal or Coke. Full and Half-Depth Regenerative Furnaces for Benches of 6's, 7's, 8's or 9's erected complete.

Proprietors of the Coze System of Inclined Retorts.
Office: 901 Pine St., **St. Louis, Mo.**

ESTABLISHED IN 1845.

B. KREISCHER & SONS,

Office, 119 E. 23d St., New York.

Gas Retorts,

TILES, FIRE BRICK.

AND EVERYTHING IN THE FIRE CLAY LINE.

Adam Weber,

Proprietor,
Manhattan Fire Brick and Enameled Clay Retort Works.
Works, Weber, N. J.
Office, 633 East 15th St., New York.

Modern Recuperative Furnaces
And Standard Fire Brick and Gas Retorts.

Works,
LOCKPORT STATION, PA.

—ESTABLISHED 1864.—
JAMES GARDNER, JR.,
Successor to WILLIAM GARDNER & SON.

Hamilton Building, Fifth Avenue,
PITTSBURGH, PA. P. O. Box 373.

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON,
(ESTABLISHED 1856.)
EXCELSIOR FIRE BRICK & CLAY
RETORT WORKS
WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y

Clay Gas Retorts,
BENCH SETTINGS,
Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT.

A Cement of great value for patching retorts, putting on mouth-pieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

PRICE LIST.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD & CO.,
N. 3d & Prospect Avs., Mt. Vernon, N.Y.
Western Agent, H. T. GEROULD, Centralia, Ills.

Parker-Russell Mining and Mfg. Co.,
CITY OFFICE,
417 Pine Street, St. Louis, Mo.

PROPRIETORS OF THE
OAKHILL GAS RETORT & FIRE BRICK W'KS

Our immense establishment is now employed almost entirely in the manufacture of

Materials for Gas Companies

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,
Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec'y
A. LAMBLA, Vice-Prest. and Supt.

BALTIMORE
RETORT & FIRE BRICK CO.

MANUFACTORY AT
LOCUST POINT BALTIMORE MD.

Clay Retorts, Blocks & Tiles
FIRE BRICK, FIRE CLAY,
AND FIRE CEMENT.

Red and Buff Ornamental Tiles and Chimney Tops. Baker Oven Tiles 12x12x2 and 16x16x2.

WALDO BROS., 88 WATER ST., BOSTON, MASS
Sole Agents for New England States.

PRACTICAL PHOTOMETRY.

A Guide to the Study of the Measurement of Light.
By WILLIAM JOSEPH DIBDIN.
With Numerous Illustrations. Price, $3.00. A. M. CALLENDER & CO. 32 Pine Street, N. Y. City

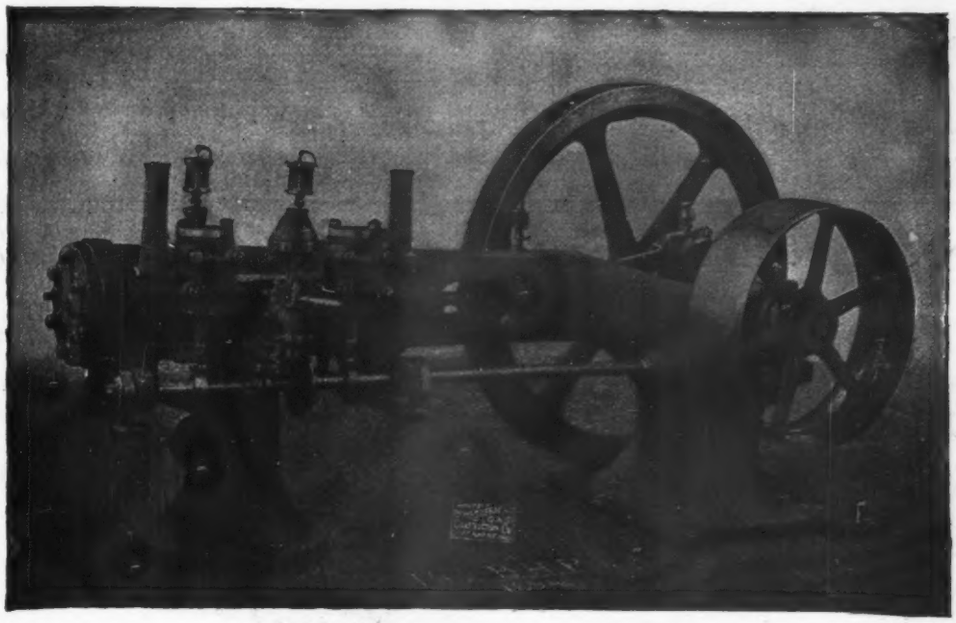
WM. W. GOODWIN, Prest. O. N. GULDLIN, V.-Prest. & Treas. H. B. GOODWIN, Sec. ERNEST F. LLOYD, Asst. Sec

THE AMERICAN GAS ENGINE CO.,

MANUFACTURERS OF

The Double-Acting Gas Engine,

Under the Patents of Griffin, and Dick, Kerr & Co., of London and Kilmarnock.



**

Single Cylinder.

Impulse Every Revolution.

(Two Strokes.)

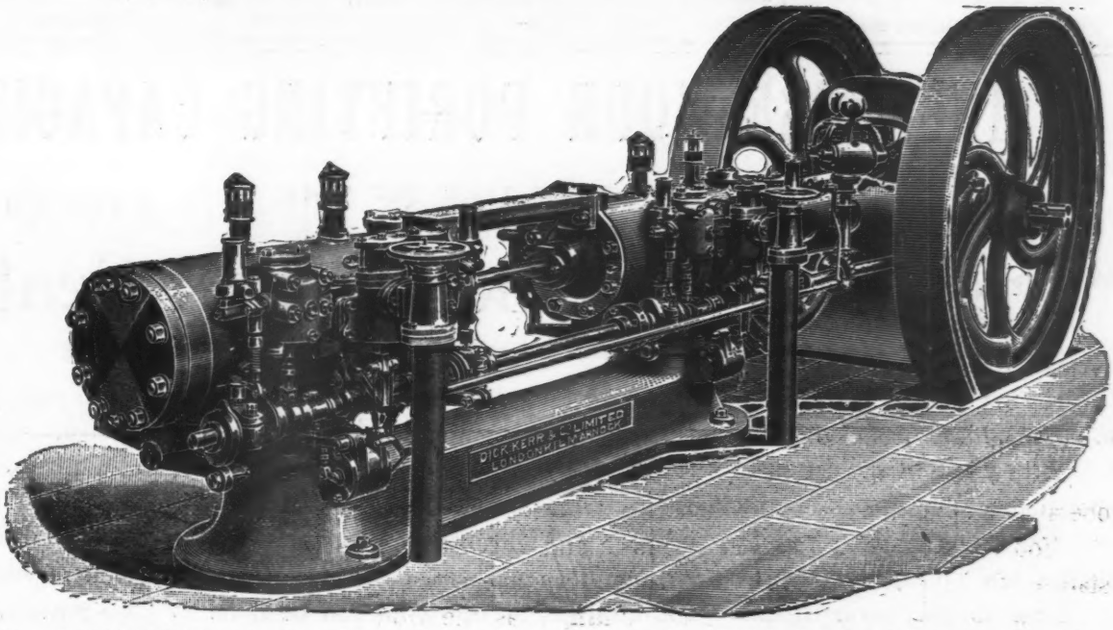
15 to 500 Horse Power.

For General Work and Isolated Electric Plants.

**

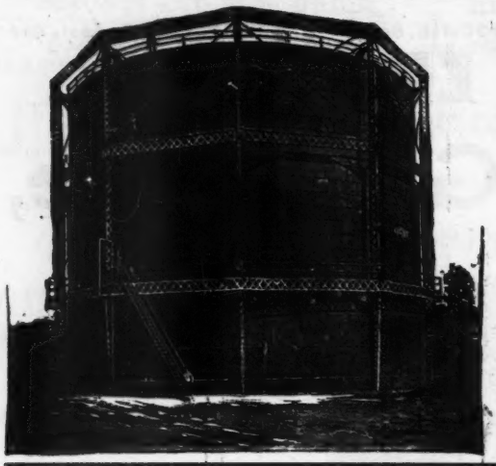
Tandem Cylinder. Impulse Every Stroke. 100 to 1,000 Horse Power.

For Central Stations and all work requiring extreme steadiness.



ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

W. W. GOODWIN, President, 532 Bourse Building, Philadelphia Pa. or
THE WESTERN GAS CONSTRUCTION CO. Bldrs. & Gen. Agts. Fort Wayne Ind.



DAVIS & FARNUM MFG. CO.,

WALTHAM, MASS.

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors, Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

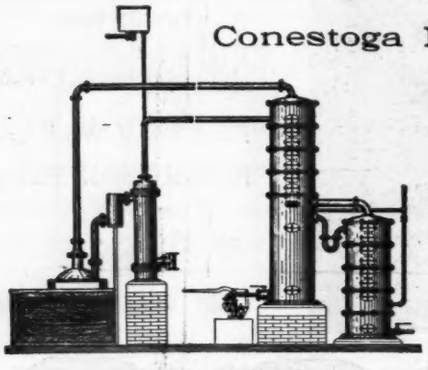
Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

GAS ENGINEERING COMPANY,

INCORPORATED,

Conestoga Building, PITTSBURGH, PA.



AMMONIA MACHINE.

MANUFACTURERS OF

Gas Works Machinery of all kinds,

PATENTEE AND OWNER OF

PITTSBURGH WASHER-SCRUBBER,

SOLE AGENT FOR

FELDMANN AMMONIA MACHINE,

For producing Sulphate, Aqua, Chloride and Concentrated Liquors.

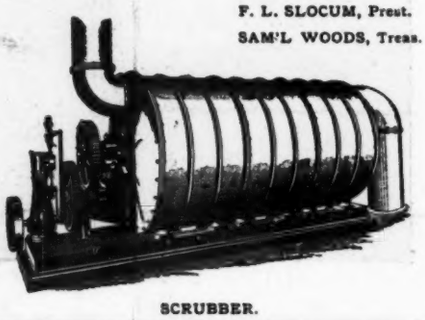
The Erection of Bi-Product Coke Ovens a Specialty.

Faux System of Recuperative Benches,

JAS. GARDNER, JR.
SOLE CONSTRUCTOR AND BUILDER.

NEW SYSTEM HYDRAULIC MAIN.

F. L. SLOCUM, Prest.
SAM'L WOODS, Treas.



SCRUBBER.

INCREASE YOUR PURIFYING CAPACITY

BY THE USE OF THE

"Crighton" Four-Box Center Seal Cap.

Having recently perfected and patented a Five-way Center Seal Cap, we are now in position to offer and recommend it to Gas Companies for increasing their purifying capacity at a moderate cost.

With this Cap you can have **all your Purifying Boxes in constant use,** and where four boxes are in operation at one time, **the capacity is increased one-third.**

Your present Center Seal can be used, and will **only require a new Cap.** Under ordinary circumstances **the change can be made in one day,** and will not necessitate the disturbing of your connections.

Now is the time to make the change, as the work can be done to good advantage during the season of your lightest output.

For information and prices address

KERR MURRAY MFG. CO.,

Manufacturers of Gas Works Apparatus and Holders,

FORT WAYNE, IND.

BARTLETT, HAYWARD & CO.

BALTIMORE, MD.

Triple, Double & Single-Lift

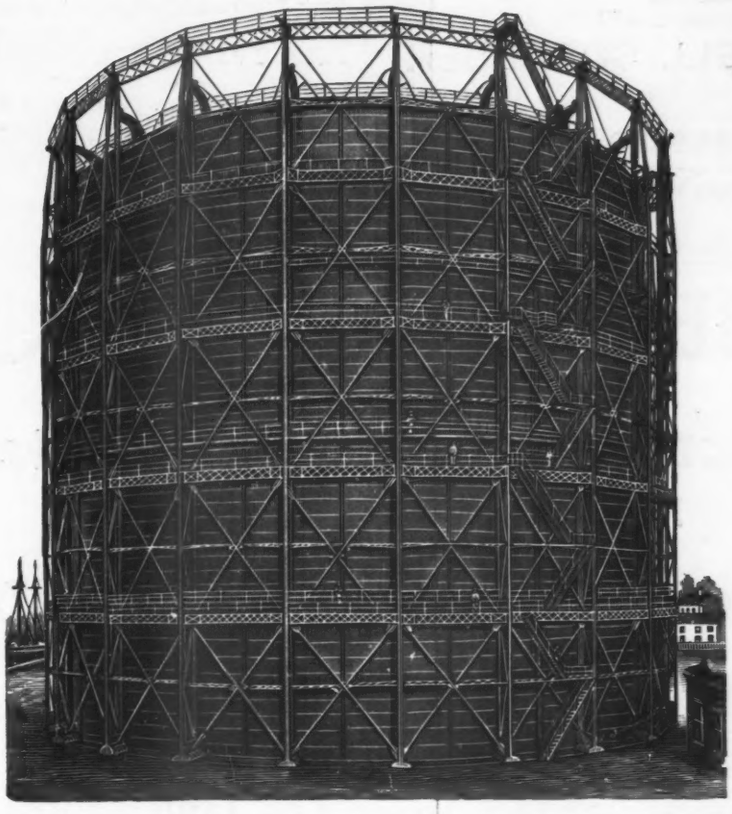
GASHOLDERS.

Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS



PURIFIERS.

CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS

Boilers.

Three Four-Lift Gasholders, each of 4,289,500 Cubic Feet Capacity, Erected in Chicago.

The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

MILL'S REVERSIBLE LIME TRAYS.

Gas Works Designed and Constructed.

W. H. PEARSON, President. J. T. WESTCOTT, Gen'l Mang'r & Treas. L. L. MERRIFIELD, Chief Engineer.

The Economical Gas Apparatus Construction Co., Ld.

269 Front Street, East, - - Toronto, Canada.

ENGINEERS AND BUILDERS

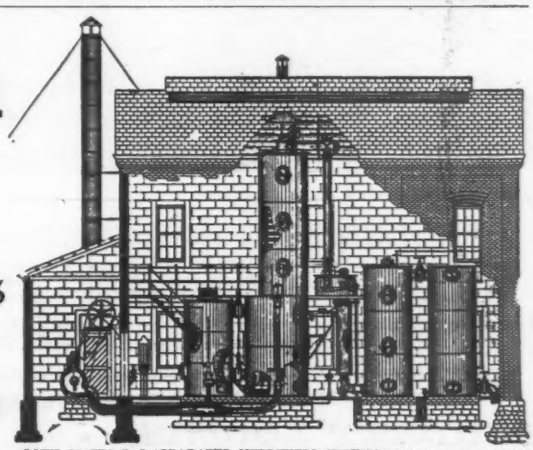
OF THE

Improved Lowe Water Gas Apparatus

Designed to give the Greatest Efficiency when using any kind of Oil, Anthracite Coal, Gas House or Oven Coke.

New Gas Works Built, Present Gas Plants, either Coal or Water, Remodeled

Catalogues, Plans and Estimates Furnished upon Application.



LOWE WATER GAS APPARATUS, MERRIFIELD-WESTCOTT-PEARSON SETTING.

Foundries and Works: { Millville, N. J. / Florence, " / Camden, "

R. D. WOOD & CO.

ENGINEERS, IRON FOUNDERS, MACHINISTS

400 Chestnut Street, PHILADELPHIA, PA.

MANUFACTURERS OF

CAST IRON PIPE

SOLE MAKERS OF

THE MITCHELL SCRUBBER

(PATENTED)

PURIFIERS, CONDENSERS, SCRUBBERS.

THE HOPPER AUTOMATIC GAS GOVERNOR.
BENCH WORK. PLATE GIRDERS.
IRON FLOORS AND ROOFS.

BUILDERS OF

GAS HOLDERS

Single, Double and Triple Lifts, with or without Wrought Iron or Steel Tanks

PEASE'S PATENT WIRE ROPE GUIDING FOR GAS HOLDERS

CUTLER'S
PATENT FREEZING PREVENTER
FOR GAS HOLDER CUPS.

THE TAYLOR REVOLVING BOTTOM GAS PRODUCER,
HEAVY LOAM CASTINGS, DUNHAM SPECIALS, HYDRAULIC WORK
LAMP POSTS, VALVES, ETC.

ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

Construction and Extension of Gas Works.

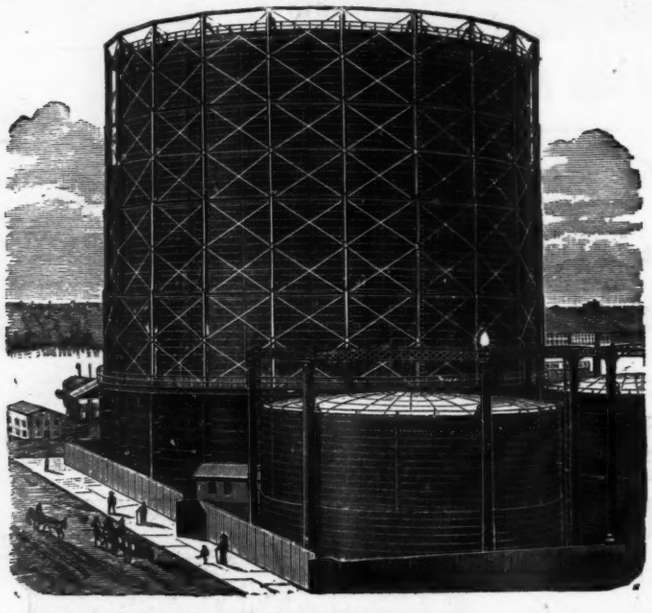
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

245 Broadway, New York City. OFFICES Bridge & Ogden Sts., Newark, N. J.



The Continental Iron Works,

THOMAS F. ROWLAND, President,
WARREN E. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

BROOKLYN, N. Y.

TAKE EAST TENTH OR TWENTY-THIRD STREET FERRIES FROM N. Y. TO GREENPOINT.

BUILDERS OF

Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

Wrought Iron Gas Holder Tanks.

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers
Purifiers, Valves, Etc.

Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cutlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

The Cheapest Gas Generating System in the World.

Plans and Estimates Furnished.

BURDETT LOOMIS, - - Hartford, Conn.

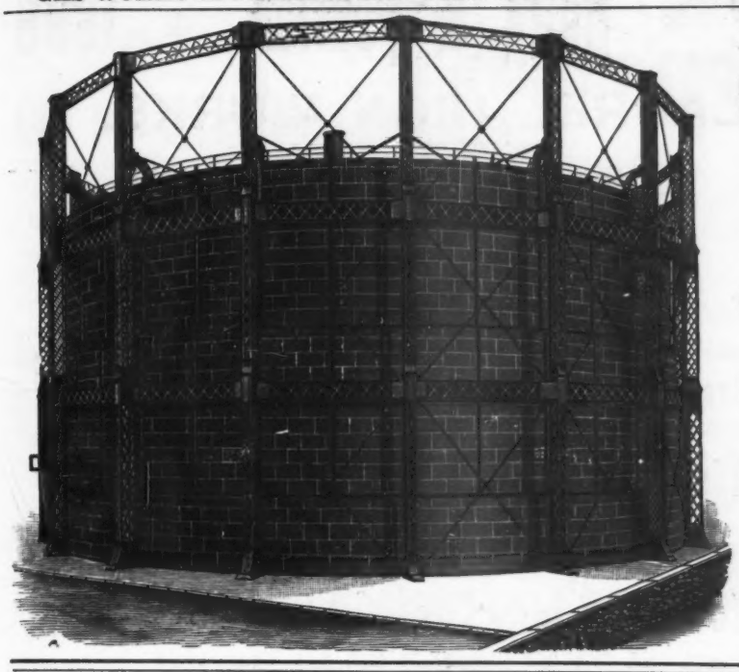
To Gas Companies.

We make to order CAP BURNERS to burn any amount under a stated pressure. Send for samples.

Also, SERVICE CLEANERS, DRIP PUMPS, and STREET MAIN PROVING APPARATUS.

C. A. GEFRORER.

948 N. 8th St., Phila., Pa.



H. RANSHAW, Prest. & Mangr. T. H. BIRCH, Asst. Mangr
WILLIAM STACEY, Vice-Prest. R. J. TARVIN, Sec. & Treas.

THE STACEY MANUFACTURING CO
Established 1851.

Single, Double and Triple-Lift

GASHOLDERS,

Of any Capacity, with or without Wrought Iron or Steel Tanks.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, etc.

Coal Gas Benches, Roof Frames,

OIL STORAGE TANKS.

Pressed Steel Mouthpiece Lids, Self-Sealing Mouthpiece Lids.

Cincinnati, Ohio.

George Shepard Page's Sons,

Sole Agents for

The "Standard" Washer-Scrubber,

The Walker Tar and Carbonic Acid Extractor, The Walker Sulphate and Ammonia Still,
The Walker Self-Sealing Pressed Steel Mouthpiece Lids.

The Berlin Center Valve. And Contractors for Ammoniacal Liquor.

No. 69 Wall Street, New York City.

The Free Attendant Service
maintained by the
New York Central at
Grand Central Station
is another example of the care and courtesy by which patrons of this great railroad are surrounded.

GEORGE R. ROWLAND.
Formerly with the Continental Iron Works.
Draughtsman and Constructing Engineer.
Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.
Office, No. 245 Broadway, N. Y. City.

T. G. LANSDEN,
Consulting and Contracting Gas Engineer
Estimates, Plans and Specifications for New Works (Coal or Water Gas), and for Extensions or Alterations.
Room H, 108 N. 4th St., St. Louis, Mo.

WM. HENRY WHITE,

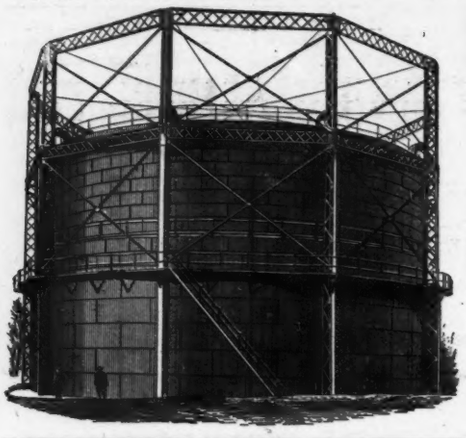
No. 32 Pine Street, - - - New York City.

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

GAS, WATER, AND ELECTRIC LIGHT WORKS.

Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited
Plans and Estimates Furnished.



1842 * Deily & Fowler, * 1896

LAUREL IRON WORKS.

Office, No. 39 Laurel Street, Philadelphia, Pa.

BUILDERS OF

Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK.

JAMES R. FLOYD & SONS,

Successors to HERRING & FLOYD,

Oregon Iron Works,

West 20th and 21st Streets, Between 10th & 11th Avenues, New York City.

Engineers and Contractors for the Construction of Gas Works.

MANUFACTURERS OF ALL KINDS OF CASTINGS AND GENERAL IRONWORK FOR GAS APPARATUS.

Bench Castings, Regenerative and Half Regenerative Furnace Castings, Condensers, Tower Scrubbers, Mechanical Scrubbers, Purifiers, Malleable Iron Retort Lids, Self-Sealing Retort Lids, Hydraulic Hoist Purifier Carriage, Crosses, Tees, Bends, Angles, Reducers, S-Bends, Sectional Sleeves, Plugs, Caps, Street Drips, etc., always on hand.

WOOD'S GAS SCRUBBING AND ENRICHING APPARATUS.

In use at Syracuse, Auburn, Watertown, Cortland and Geneva, N.Y.; Elizabeth, N. J.; Boston, Mass.; Jamaica Plain, Mass.; Providence, R. I.; Northern Liberties Gas Co., Phila.

Sole Manufacturers of the OGDEN QUICK-MOVING VALVE.

Premium Awarded, World's Columbian Exposition.

HEARNE CENTER SEAL, Operating One, Two, Three or Four Boxes.

SCIENTIFIC BOOKS.

GAS MANUFACTURE, by William Richards. 4to., with numerous Engravings and Plates, in Cloth binding. $12.

TECHNICAL GAS ANALYSIS. $3.

GAS CONSUMER'S HANDYBOOK, by Wm. Richards, C.E. 20 cents.

PRACTICAL TREATISE ON HEAT AND VENTILATION, with Special Relation to Illuminating, Heating and Cooking by Gas. By E. E. Perkins. $1.25.

CHEMISTRY OF ILLUMINATING GAS. By Norton H. Humphrys. $2.40.

PRACTICAL TREATISE ON HEAT By Thomas Box. 2d edition. $5.

PRACTICAL PHOTOMETRY: A Guide to the Study of the Measurement of Light. By W. J. Dibdin. $3.

CHEMICAL TECHNOLOGY: Vol. I., *Fuel and Its Applications*, $5. Vol. II., *Lighting*, $4.

IRONWORK: Practical Designing of Structural Ironwork. By H. Adams. $3.50.

GAS WORKS: Their Arrangement, Construction, Plant and Machinery. $5.

PRACTICAL HANDBOOK ON GAS ENGINES, by G. Lieckfield. $1.

LIQUID FUEL FOR MECHANICAL AND INDUSTRIAL PURPOSES. By E. A. Brayley Hodgetts. $2.50.

COAL, SPONTANEOUS COMBUSTION OF. By Thomas Rowan, C.E. $2.

COAL: Its History and Use. By Prof. Thorpe. $3.50.

THE GAS WORKS OF LONDON. By Colburn. 60 cents.

HEAT A MODE OF MOTION. By John Tyndall. $2.50.

THE MANAGEMENT OF SMALL GAS WORKS. By C. J. R. Humphreys. $1.

MANUAL FOR GAS ENGINEERING STUDENTS. By D. Lee. 40 cents.

THEORY OF HEAT. By J. Clerk-Maxwell. $1.50.

AMMONIA AND AMMONIUM COMPOUNDS. By Dr. R. Arnold. $2.

DIGEST OF GAS CASES. $5.

PRACTICAL HINTS ON REGENERATOR FURNACES By M. Graham. $1.25.

DISTILLATION OF COAL TAR AND AMMONIACAL LIQUOR. By Geo. Lunge. New edition. $12.50.

A TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS. By D. A. Graham. $3.

A TEXT BOOK OF INORGANIC CHEMISTRY. By Prof. Victor Von Richter. $2.

ILLUMINATING AND HEATING GAS. By W. Burns. $1.50

HANDBOOK FOR MECHANICAL ENGINEERS. By H. Adams. $2.50.

TREATISE ON MASONRY CONSTRUCTION. Baker. $5.

GAS ENGINEER'S LABORATORY HANDBOOK. By Jno. Hornby, F.I.C. $2.50.

GAS LIGHTING AND GAS FITTING. By W. P. Gerhard. 50 cents.

PRACTICAL PLUMBING. By P. J. Davies. $3.

AMERICAN PLUMBING. By Alfred Revill. $2.

CEMENT; A Manual of Lime and Cement, their Treatmen and Use in Construction. By A. H. Heath. $2.50.

ELECTRICITY.

INDUSTRIAL PHOTOMETRY, with Special Application to Electric Lighting. By A. Palaz, Sc.D. $4.

ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson. $1.50.

ELECTRIC TRANSMISSION OF ENERGY. By G. Knapp. $3.

ELECTRICIAN'S POCKETBOOK. By Monroe and Jamieson. $2.50.

MAGNETISM AND ELECTRICITY. By J. Overend 40 cts.

DYNAMO BUILDING. By F. W. Walker. 50 cents.

DOMESTIC ELECTRICITY FOR AMATEURS. By E. Hospitalier. $2.50.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. $1.

PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES. $1.

ELECTRIC LIGHTING, by Francis B. Crocker, E.M. $3.

ELECTRIC LIGHT FITTING. $2.

PRACTICAL ELECTRICITY. $2.50.

ELECTRICITY FOR ENGINEERS. $2.50.

ELECTRIICITY, Its Theory, Sources and Applications. by John T. Sprague, M.I.E.E. $3.

The above will be forwarded upon receipt of price. If sent by mail or express, postage or express charges must be added to above prices. We take especial pains in securing and forwarding any other Works that may be desired, upon receipt of order. All remittances should be made by check, draft, or post office money order. No books sent C.O.D.

A. M. CALLENDER & CO., 32 Pine Street, New York.

GAS AND WATER PIPES.

THE OHIO PIPE COMPANY,
MANUFACTURERS OF
Cast Iron Gas & Water Pipe,
BRANCH AND SPECIAL CASTINGS.
Gas-House Bench Castings, Hydraulics, Lamp Posts, Flange Pipe and Specials, Architectural Castings, Building Columns, Joists, Cellar Grates, Sash Weights, etc.
GENERAL FOUNDERS AND MACHINISTS
Columbus, Ohio.

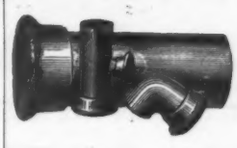
Cast Iron Pipe
For Natural or
Artificial Gas,
Flange Pipe,
Electric Light Posts.

The Addyston
Pipe & Steel Co.,
Cincinnati, O.

On the New York Central
You travel in perfect security,
protected every foot of the way by
Block Signals

GAS METERS.

WARREN FOUNDRY AND MACHINE CO.,
Established 1856. Works at Phillipsburgh, N. J.
New York Office, 160 Broadway.



CAST IRON WATER AND GAS PIPE,
FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF
Flange Pipe for Sugar House and Mine Work. Branches. Bends, Retorts, etc., etc

GEORGE ORMROD, Manar. & Treas., Emaus, Pa.
JOHN DONALDSON, Prest., Betz Bldg., Phila., Pa
EMAUS PIPE FOUNDRY.
DONALDSON IRON COMPANY. EMAUS, PA

MANUFACTURERS OF
CAST IRON PIPE AND SPECIAL CASTINGS
FOR WATER AND GAS.
Also, FLANGE PIPE, LAMP POSTS, Etc.

A CONVENIENT
BINDER for the JOURNAL

STRONG.
DURABLE.
LIGHT.
SIMPLE
CHEAP.
HANDSOME.
Price, $1.
A.M. Callender & Co.,
32 Pine st.,
N. Y. City

DAVID LEAVITT HOUGH,
26 CORTLANDT ST., N.Y. CITY.

Consulting Engineer
Investigations and Appraisals.
Designs and Estimates.
Contractor.
Machinery and Structures.
Gas and Water Pipe.
Special Agent for Selling & Purchasing

1894 DIRECTORY 1894
OF AMERICAN GAS COMPANIES
Price, - - - - - - - - - $5.00.
A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

PRACTICAL HANDBOOK ON
GAS ENGINES
With Instructions for Care and Working of the Same.
By G. LIECKFELD, C.E.
Translated with Permission of the author by GEO. M. RICHMOND, M.E.
Price, $1.00.
A. M. CALLENDER & CO., 32 Pine Street, New York.

NATHANIEL TUFTS METER CO.,

63 Beverly Street, Boston, Mass.

MANUFACTURERS OF

DRY GAS METERS.

Station Meters of any Capacity.

Test and Experimental Meters, Pressure Registers, Pressure Gauges.

METER PROVERS, PHOTOMETERS, STREET LANTERNS, ETC., ETC.

Apparatus for the Chemical Testing of Gas and Gas Liquor.

Established 1849. With the best facilities for manufacturing, is enabled to furnish reliable work and answer orders promptly.

CHARLES E. DICKEY. JAMES B. SMALLWOOD. CHARLES H. DICKEY.

THE MARYLAND METER AND MANUFACTURING CO.

Established 1866.

BALTIMORE, North & Saratoga Sts. **CHICAGO, 107 West Monroe St.**
NEW YORK, 838 Broadway. **SAN FRANCISCO, 221 Front St.**
BOSTON, 92 Water Street, Rooms 21 and 22.

CONSUMERS' & STATION METERS, PRESSURE GAUGES, Etc., Etc.

"Perfect" Gas Stoves

THE GOODWIN METER COMPANY,

1012-1018 Filbert Street, Philadelphia, Pa.

MANUFACTURERS OF

Consumers' and Station Meters,

Standard Photometrical and Analytical Gas Apparatus

"SUN DIAL" GAS COOKING AND HEATING STOVES.

Particular attention given to Repairing Meters and Scientific Apparatus. . . .

GEORGE B. EDWARDS, Agent,
113 Chambers Street, N. Y. City.

METRIC METAL COMPANY,

MANUFACTURERS OF

DRY GAS METERS

For all Kinds of Service.

ALSO MAKERS OF THE

MATCHLESS CLASSIC GAS COOK STOVES AND RANGES.

Send for '96 Stove Catalogue. Factory at Erie, Pa.

GAS METERS. GAS METERS. GAS METERS.

THE AMERICAN METER CO.

Established 1834. Incorporated 1863.

WET AND DRY GAS METERS. PRESSURE REGISTERS. METER PROVERS.
STATION METERS. PRESSURE & VACUUM REGISTERS. PORTABLE TEST METERS.
EXHAUSTER GOVERNORS. PRESSURE & VACUUM GAUGES. EXPERIMENTAL METERS.
DRY CENTER VALVES. CRESSON GAS REGULATORS. AMMONIA TEST METERS.
GOVERNORS FOR GAS WORKS. MARSLAND WATER METERS. BAR & JET PHOTOMETERS.

Manufactories:
512 West 22d St., N. Y.
Arch & 22d Sts., Phila.

GAS STOVES.
SUGG'S "STANDARD" ARGAND BURNERS,
SUGG'S ILLUMINATING POWER METER,
Wet Meters with Lizar's "Invariable Measuring" Drum.

Agencies:
125 & 127 S. Clinton Street, Chicago.
810 North Second Street, St. Louis.
222 Sutter Street, San Francisco.

HELME & McILHENNY,

Established 1848. 1339 to 1349 Cherry Street, Philadelphia, Pa.

MANUFACTURERS OF

Wet and Dry Gas Meters, Station Meters, Provers, Gauges, Etc.

METERS REPAIRED

PREPAYMENT GAS METERS.

Our Own Patents. Strong. Simple. PROMPT ATTENTION. CORRESPONDENCE SOLICITED.

D. McDONALD & CO.,

Established 1854.

511 West 21st Street, NEW YORK CITY.
51, 53 & 55 Lancaster St., ALBANY, N. Y.
34 & 36 W. Monroe St., CHICAGO, ILL.

MANUFACTURERS OF

Wet and Dry Gas Meters

STATION METERS, EXPERIMENTAL METERS, METER PROVERS, PRESSURE & VACUUM REGISTERS & PRESSURE GAUGES.

Meters of all makers Thoroughly Repaired.

THEODORE D. BUHL, President. CHARLES H. JACOBS, Vice-President and Managing Director.

BUHL STAMPING CO. RELIABLE GAS METERS DETROIT, MICH. U.S.A.

Buhl Stamping Company,

Detroit, Mich.

Manufacturers of Gas Meters of the Highest Quality.

METER REPAIRING A SPECIALTY. SEND FOR OUR PRICE LIST.

Detroit is one of the best shipping points in the United States for prompt deliveries by rail or water to the East, West or South.

BUHL Meters will need few Repairs. We make our own Tin Plate. Trial Orders Solicited.

The advertisement of

JOHN J. GRIFFIN & CO., Mfrs. of Gas Meters, etc.,

Nos. 1513, 1515, 1517, 1519 & 1521 Race Street, Philadelphia,
52 Dey Street, New York, 75 N. Clinton Street, Chicago,

Occupies this page every alternate week

UNEQUALED

For efficiency and low gas consumption.
For smooth and quiet running.
For simplicity of construction and grace in design.
For general reliability.
For close regulation of power.

150 MEDALS AND DIPLOMAS.

The "OTTO"--The First.

The First to use the four-stroke cycle. **The First** to admit well measured and distinct charges of gas into an air space. **The First** in the adoption of poppet valves. **The First** to develop the tube igniter, with automatic or timed firing. **The First** to have a reliable electric and a practical magnectic igniter.

THE FIRST SMOOTH RUNNING & NOISELESS GAS ENGINE COMBINING EFFICIENCY & SIMPLICITY.

Our Columbian Style

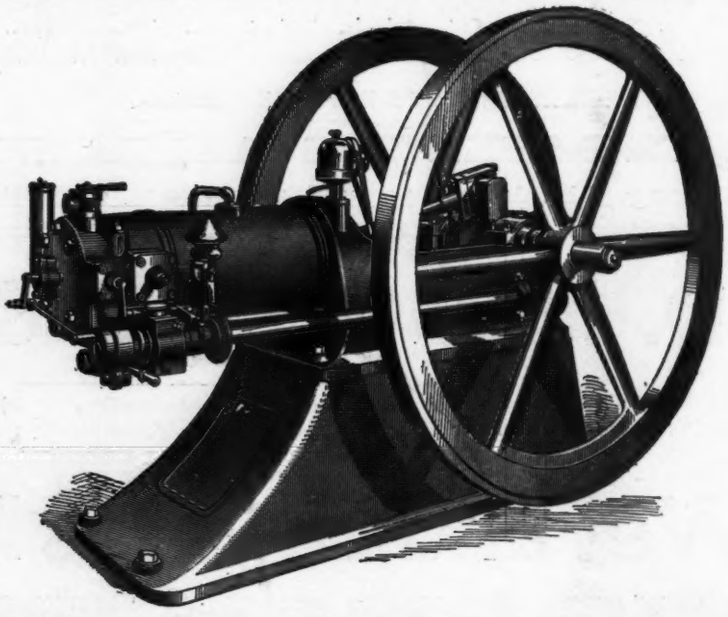
IS FITTED

With removable seats and casings for all valves.

With Patent Alloy Tube, good for one year.

With timing device for ignition, preventing starting backward; or with electric igniter.

OVER 45,000 SOLD.



SIMPLICITY, as far as is possible, with good design and perfect Working. Built on scientific principles, with a view to **HIGHEST EFFICIENCY**

Sizes,
One to 250 H.P.

The First and Only Engine To-day to Please Every Purchaser

DEMONSTRATION

It is almost a quarter of a century since the "Otto" revolutionized old and bad practices by introducing principles of combustion "entirely new" in the construction of Gas Motors.

A quarter of a century of uninterrupted success has demonstrated the correctness of these principles.

The gas engine history of the past proves that all competitors have recognized this fact by becoming imitators.

Since its advent the "Otto" engine has been illustrating mechanical improvement without alteration, while others have been offering alterations as improvements.

The experience of the past shows that it requires years to determine the real merits of a gas engine, and that nearly all new gas engines prove failures. **The fittest survive, and the only safe thing to do** in selecting a gas engine is to buy what the tests of practical use, through a long period of time, have proven to be the best.

The Practical Tests of a Quarter of a Century have Demonstrated that the "OTTO" Stands To-day Unrivaled

For simplicity of construction and grace in design; for general reliability and ease of management; for quiet and smooth running qualities; for efficiency and low gas consumption; for regularity of speed and close regulation of power.

"OTTO GAS ENGINE WORKS," Inc., 33d & Walnut Streets, Phila., Pa.

NEW YORK 18 Vesey St BOSTON, 19 Pearl St. CHICAGO, 245 Lake St.